Notice No.8

Rules and Regulations for the Classification of Ships, July 2016

The status of this Rule set is amended as shown and is now to be read in conjunction with this and prior Notices. Any corrigenda included in the Notice are effective immediately.

Please note that corrigenda amends to paragraphs, Tables and Figures are not shown in their entirety.

Issue date: June 2017

Amendments to	Effective date	Mandatory Instrument
Part 3, Chapter 1, Section 5	1 July 2017	NA
Part 3, Chapter 4, Section 8	1 July 2017	NA
Part 3, Chapter 13, Section 8	1 July 2017	NA
Part 3, Chapter 14, Sections 1, 5, 7, 8 & 9	1 July 2017	NA
Part 4, Chapter 1, Sections 4, 5 & 6	1 July 2017	NA
Part 4, Chapter 1, Section 6	Corrigenda	NA
Part 4, Chapter 2, Section 2	1 July 2017	NA
Part 4, Chapter 7, Section 1	1 July 2017	NA
Part 4, Chapter 8, Sections 3, 14 & 16	1 July 2017	NA
Part 4, Chapter 8, Section 15	Corrigendum	NA
Part 4, Chapter 9, Section 1	1 July 2017	NA

Lloyd's Register

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Part 3, Chapter 1
General

■ *Section 5*
Information required

5.3 Plans to be supplied to the ship

Existing sub-Section 5.3 has been deleted in its entirety.

5.3.1 A Ship Construction File is to be provided on board of the ship containing information to facilitate inspection/survey, repair and maintenance. As a minimum it is to include the following documentation and plans:

(a) Copies of approved as-built plans, including the main scantling plans are to be placed on board the ship. These plans are to indicate, as applicable, the disposition and grades (other than Grade A) of hull structural steel, the extent and location of higher tensile steel together with details of specification and mechanical properties, location of butts and seams, cross-section details and locations of all partial and full penetration welds, areas identified for close attention and rudders, wastage allowances and any recommendations for welding, working and treatment of these steels.

(b) Similar information is to be provided on board when aluminium alloy or other materials are used in the hull construction.

(c) Copies of certificates of forgings and castings welded into the hull.

(d) Details of equipment forming part of the watertight and weather tight integrity of the ship.

(e) The approved tank testing plan including details of the test requirements.

(f) Docking plan and details of all penetrations normally examined at dry-docking.

(g) Ship structure access manual, as applicable.

(h) A copy of the final Loading Manual, when approved, and details of the loadings applicable to approved decks, hatch covers and inner bottom.

(i) Operations and maintenance manuals required for classification (e.g. hatch cover and coamings, shell doors and container securing arrangements).

(j) Details of any corrosion prevention systems applied or fitted.

(k) For ships that are required to comply with IMO *Performance Standard for Protective Coatings*, a copy of the Coating Technical File (CTF), *see Ch 15 Corrosion Prevention* of the *Rules for the Manufacture, Testing and Certification of Materials, July 2016, incorporating Notice No. 1&2*.

(l) Where an ***IWS** (In-water Survey) notation is to be assigned, approved plans and information covering the items detailed in *Pt 3, Ch 1, 5.2 Plans and supporting calculations* 5.2.4 .

(m) Where the ShipRight notation **CM** is to be assigned, the approved Construction Monitoring Plan (CMP), as detailed in the *ShipRight Construction Monitoring* Procedures.

(n) The towing and mooring arrangements plan is to be provided for the guidance of the Master. The information provided on the plan is to include the following in respect of each shipboard fitting:

- Location on the ship.
- Fitting type.
- Safe working load (SWL).
- Purpose of fitting (mooring/harbour towing/escort towing).
- Manner of applying towing or mooring line load, including limiting fleet angles.
- Strength of each mooring line.
- The number of mooring lines supplied on board the ship.

This information is to be incorporated into the pilot card in order to provide the pilot with the necessary information on harbour/escorting operations.

(o) Details of the principal dimensions, the freeboard marks and draft marks.

■ *Section 8*
Loading guidance information

8.4 Onboard lashing program

8.4.1 An onboard lashing program to calculate forces acting on the container stowage arrangement may be provided, *see Pt 3, Ch 14 Cargo Securing Arrangements*. This may be an extension to the loading instrument covered under *Pt 3, Ch 4, 8.3 Loading instrument*. If the software to carry out lashing calculations is installed and maintained in accordance with the Rules, the ship will be eligible to be assigned the special features notation **BoxMax**, with one or more of the supplementary letters **V** and **W**. The notation **BoxMax(V,W)** may be supplemented with the letter **L** if the conditions for this notation are satisfied.

8.4.2 For description of the **BoxMax** notation and its **V**, **W** and **L** features, *see Pt 3, Ch 14, 1.2 Classification notations and descriptive notes*.

~~8.4.2~~ 8.4.3 To qualify for the notation **BoxMax** the following requirements must be satisfied:

(a) The onboard lashing program is to be certified in accordance with LR's *Approval of ~~Longitudinal~~ Strength and Stability Calculation Programs*.

(b) Where alteration to the container stowage arrangements is proposed, the onboard lashing program is to be modified accordingly and details submitted for approval.

(c) The operation of the onboard lashing program is to be verified by the Surveyors upon installation and at Annual and Periodical Surveys as required in *Pt 1, Ch 3 Periodical Survey Regulations*. An Operation Manual for the onboard lashing program is to be verified as being available on board.

~~8.4.3 The onboard lashing program may also have the capability to take account of the various sea areas through which the container ship may trade. If the software to carry out lashing calculations is installed and maintained in accordance with the Rules and includes the functionality to take account of voyage route using the methodology and factors supplied by LR, the ship will be eligible to be assigned the special features notation **BoxMax(V)**.~~

8.4.4 To qualify for the aspects of the notation, i.e. **V**, **W** and **L**, the Surveyor is to verify upon installation and at Annual and Periodical Surveys as required in *Pt 1, Ch 3 Periodical Survey Regulations,* that the individual features of the notation are implemented in the onboard lashing program. The Surveyor is also to verify that an Operation Manual for these aspects of the onboard lashing program is available onboard.

~~8.4.4 To qualify for the notation **BoxMax(V)** the following requirements must be satisfied:~~

~~(a) The requirements for **BoxMax** must be satisfied.~~

~~(b) The benefits of the notation may only be applied in sea areas for which LR has provided the factors for the ship. Elsewhere, the weather-dependent factors must be set to the values defined for unrestricted worldwide service, *see Pt 3, Ch 14, 1.5 Symbols and definitions.*~~

~~(c) The voyage-specific aspects of the onboard lashing program are to be verified by the Surveyors upon installation and at Annual and Periodical Surveys as required in *Pt 1, Ch 3 Periodical Survey Regulations*. An Operations Manual for these aspects of the onboard lashing program is to be verified as being available on board.~~

~~8.4.5 The onboard lashing program may also have the capability to take account of the various seasons during which the container ship may trade. If the software to carry out lashing calculations is installed and maintained in accordance with the Rules and includes the functionality to take account of voyage route and season using the methodology and factors supplied by LR, the ship will be eligible to be assigned the special features notation **BoxMax(V,W)**.~~

~~8.4.6 To qualify for the notation **BoxMax(V,W)** the following requirements must be satisfied:~~

~~(a) The requirements for **BoxMax(V)** must be satisfied.~~

~~(b) The benefits of the notation may only be applied in sea areas and during seasons for which LR has provided the factors for the ship. If the required sea areas and seasons are not fully covered by the factors provided by LR, the weather-dependent factors must be set to the values defined for the notation **BoxMax(V)**, if available, or for unrestricted worldwide service, *see Pt 3, Ch 14, 1.5 Symbols and definitions.*~~

~~(c) The voyage- and season-specific aspects of the onboard lashing program are to be verified by the Surveyors upon installation and at Annual and Periodical Surveys as required in *Pt 1, Ch 3 Periodical Survey Regulations*. An Operation Manual for these aspects of the onboard lashing program is to be verified as being available on board.~~

Part 3, Chapter 13
Ship Control Systems

■ *Section 8*
Windlass design and testing

8.2 Calculations

Table 13.8.2 Design load cases for the windlass

Load case	Condition	Note
1	Continuous pull	*See Pt 3, Ch 13, 8.1 Windlass design 8.1.2(a)*
2	~~Over load~~ Overload pull	*See Pt 3, Ch 13, 8.1 Windlass design 8.1.2(b)*
3	Brake holding load	*See Pt 3, Ch 13, 8.1 Windlass design 8.1.2(c)*

8.10 Structural requirements associated with anchoring

8.10.1 The windlass or winch is to be efficiently bedded and secured to the deck. The thickness of the deck in way of the windlass or winch is to be increased~~, and adequate stiffening is to be provided, to the Surveyor's satisfaction.~~ and the supporting structure for the anchor windlass is to be examined for the brake holding loads specified by *Table 13.8.2 Design load cases for the windlass*. The allowable stresses specified in *Table 13.8.4 Allowable stress in windlass and chain stopper supporting structure* are to be used to derive the net scantlings of the supporting structure. A corrosion addition of 2mm is to be added to the net thickness derived. The structural design integrity of the bedplate is the responsibility of the Shipbuilder and windlass or winch manufacturer.

8.10.2 Where cables pass through stoppers, these stoppers are to be manufactured from ductile material and be designed to minimise the possibility of damage to, or snagging of, the cable. They are to be capable of withstanding without permanent deformation a load equal to 80 per cent of the Rule breaking load of the cable passing over them. The allowable stresses specified in *Table 13.8.4 Allowable stresses in windlass and chain stopper supporting structure* are to be used to derive the net scantlings of the supporting structure. A corrosion addition of 2 mm is to be added to the net thickness derived.

Table 13.8.4 Allowable stresses in windlass and chain stopper supporting structure

	Permissible stress N/mm^2
Normal stress (*see* Note 1)	1,00 σ_0
Shear stress	0,58 σ_0
Symbols	
σ_0 = specified minimum yield stress, N/mm^2	
Note 1 Normal stress is defined as the sum of bending and axial stresses.	

8.11 Structural requirements for windlasses on exposed fore decks

8.11.9 The windlass is to be efficiently bedded and secured to the deck. The thickness of the deck in way of the windlass is to be increased. Adequate stiffening of the deck in way of the windlass is to be provided. The scantlings of the supporting structure and deck are to be determined by additional calculations applying the weight of the windlass combined with the resultant force on the seat due to the application of the following design loads:

- P_x (as defined in *Pt 3, Ch 13, 8.11 Structural requirements for windlasses on exposed fore decks 8.11.4*);
- P_y;
- P_x and P_y combined;
- ~~a load no less than the maximum pull developed by the windlass under normal operating conditions;~~
- ~~a load no less than the ultimate breaking strength of the chain stopper, but need not be taken greater than the maximum brake holding capacity of the windlass.~~

The allowable stresses given in *Table 13.8.5 Allowable stress in windlass supporting structure for green sea loading* are not to be exceeded.

Table 13.8.5 Allowable stress in windlass supporting structure for green sea loading

	Bending stress, in N/mm^2	Shear stress, in N/mm^2	Combined Stress, in N/mm^2
Allowable Stress	$\frac{150}{k}$	$\frac{87}{k}$	$\frac{213}{k}$
k = material factor, *see Pt 3, Ch 2, 1.2 Steel*			

Part 3, Chapter 14
Cargo Securing Arrangements

■ *Section 1*
General

1.2 Classification notations and descriptive notes

1.2.3 The advantage of having an onboard lashing program to calculate forces acting on the stowage arrangement is highlighted. It is recommended that all ships carrying containers on a regular basis be equipped with such a tool. This may be an extension to the loading instrument covered under *Pt 3, Ch 4, 8.3 Loading instrument*. It is recommended that the program be approved by LR. If the program to carry out lashing calculations is approved by LR and installed and maintained in accordance with the requirements of~~ this Chapter~~ *Pt 3, Ch 4, 8.4 Onboard lashing program*, the ship will be eligible to be assigned the special features notation **BoxMax**.

1.2.5 The container securing arrangements of a container ship may take into account specific voyage routes and seasons, provided the ship ~~is eligible for~~ has been assigned the special features notation **BoxMax**~~, *see Pt 3, Ch 14, 1.2 Classification notations and descriptive notes 1.2.3*, the onboard lashing program is capable of performing calculations specific to defined sea areas and seasons and the weather-dependent factors for these areas and seasons have been supplied by LR. In this case, if the weather-dependent factors have been supplied by LR for specific sea areas, the ship will be eligible to be assigned the special features notation **BoxMax(V)**. If the factors have been supplied by LR for specific sea areas and seasons, the ship will be eligible to be assigned the special features notation **BoxMax(V,W)**. *See Pt 3, Ch 4, 8.3 Loading instrument.*~~ with one of the following supplementary letter sequences: **V** or **V,W** or **V,W,L**. The features offered by these supplementary letter sequences are defined in *Table 14.1.1 BoxMax notation features.*

1.2.6 The onboard lashing program is to be capable of performing calculations specific to defined sea areas and seasons, and the weather-dependent factors for these areas and seasons have been supplied by LR.

- If the weather-dependent factors have been supplied by LR for specific sea areas, the ship will be eligible to be assigned the special features notation **BoxMax(V)**.
- If the factors have been supplied by LR for specific sea areas in combination with seasons, the ship will be eligible to be assigned the special features notation **BoxMax(V,W)**.

See also Pt 3, Ch 4, 8.4 Onboard lashing program.

1.2.7 For details of the individual features for the **BoxMax** notation, *see Table 14.1.1 BoxMax notation features*.

Existing paragraph 1.2.6 has been renumbered 1.2.8.

1.2.9 The Operational Guidance Document, *see Pt 3, Ch 14, 1.6 Symbols 1.6.1*, is only considered applicable if the vessel is assigned and is operated with the **BoxMax** notation.

Table 14.1.1 BoxMax notation features

Notation	Additional feature description
BoxMax(V)	**V**: Voyage dependencies The assessment of the loads acting on the containers and the container securing arrangements may take account of the areas on the trading route of the ship. The North Atlantic represents one of the most severe weather areas in the world. For other areas the weather conditions may be less severe, and hence the assignment of the **BoxMax(V)** notation allows weather dependent factors to be applied to the environmental (dynamic) loads acting on the container stacks in-hold or on-deck. For the **V** feature, the weather dependent factors are determined on the basis of the annual environmental wave data, *see* Note 1. The weather dependent factors applicable to annual environmental wave data for the requested sea areas will be supplied by LR, *see* Note 2.
BoxMax(V,W)	**W**: Weather dependency (Season dependency) The **BoxMax(V,W)** notation allows the change in weather conditions for various seasons to be taken into account for the assessment of the environmental loads acting on container stacks in-hold or on-deck. For example, this allows enhanced flexibility for the carriage of containers in the summer season, when the weather conditions are usually less severe than in the winter months. For the **W** feature, the weather dependent factors are determined on the basis of the seasonal environmental wave data. The weather dependent factors applicable to seasonal environmental wave data for the requested sea areas will be supplied by LR, see Note 2.
BoxMax(V,W,L)	**L**: Limited duration voyages The **BoxMax(V,W,L)** notation potentially allows increased flexibility for the carriage of containers on-board the ship for limited duration voyages. When applying the **L** feature, limited duration voyage factors are applicable for voyages

<table>
<tr><td></td><td>of less than 48 hours. They are suitable for short coastal voyages, for example between ports such as Hamburg and Rotterdam or between Hong Kong and Xiamen (China). Typically it will allow enhanced flexibility for the carriage of containers and may allow reduced lashing requirements between local ports.
The process of application of the BoxMax(V,W,L) limited duration voyage feature is given in <i>Pt 3 ,Ch 14, 1.3 Application of the BoxMax(V,W,L) notation</i>.
The weather dependent factors applicable to limited duration voyages based on wave heights predicted by weather forecasts will be supplied by LR.</td></tr>
<tr><td colspan="2">Note 1: The weather dependent factors are described in <i>Pt 3, Ch 14, 1.6 Symbols</i>.
Note 2: LR will supply weather dependent factors applicable to the list of sea areas requested by the owner. The requested sea areas must cover the whole of the voyage route to be used. If the vessel sails outside of the requested sea areas then all the weather dependent factors should be set to 1,0.</td></tr>
</table>

1.3 Application of the BoxMax(V,W,L) notation

1.3.1 The **BoxMax(V,W,L)** notation requires the following process to be applied by the Ship's Master.

1.3.2 For the limited duration voyage feature to be applicable the following process must be in place:

(a) The ship must subscribe to an ocean weather forecast service provided by a recognised and reputable met ocean weather forecasting organisation. The forecast is to include wind speed and wave heights for a minimum period of 5 days and preferably 10 days. The responsibility for selection of the weather forecasting organisation lies with the Master.

(b) The ship must have the Operational Guidance document on board, as described in *Pt 3, Ch 14, 1.6 Symbols*.

(c) The Master should take care to ensure that the ship avoids speeds and headings where large rolling motions are indicated in the Operational Guidance document.

1.3.3 The limited duration voyage feature can only be applied in the following scenarios:

(a) The maximum length of a limited duration voyage is 48 hours in Open Water. A limited duration voyage may be slightly extended at the Master's discretion provided the forecast is favourable. Voyages longer than this will need to be considered using the **BoxMax(V,W)** approaches.

(b) There should be no warnings for major storms with maximum sustained winds of more than 119 km per hour for an area within 500 miles from the long-range weather forecast.

where:

Open Water	May be taken as starting at the outer harbour limits or harbour breakwater, as applicable. The concept of Open Water here is used to define the point at which the ship will leave the confines of the port and any estuaries or inshore navigation confines.
T_{depart}	Is to be taken as the estimated time in hours after the initial forecast that the ship enters Open Water after leaving the port of departure.
T_{arrive}	Is to be taken as the estimated time in hours after the initial forecast that the ship leaves Open Water prior to entering the port of arrival.

1.3.4 The supplied weather dependent factors applicable to limited duration voyages are based on the significant wave height.

1.3.5 The Master needs to select the appropriate significant wave height for the limited duration voyage, H_{SL}. The significant wave height for the limited duration voyage is to be rounded up to the next integer and is to be selected as follows:

H_{SL} = $\mathrm{H}_{\mathrm{forecast}}$ if the $\mathrm{T}_{\mathrm{arrive}}$ is less than 72 hours after the time of the initial forecast.
= $\mathrm{H}_{\mathrm{forecast}} + 1\ \mathrm{m}$ if the $\mathrm{T}_{\mathrm{arrive}}$ is more than 72 hours after the time of the initial forecast
= $\mathrm{H}_{\mathrm{forecast}} + 2\ \mathrm{m}$ if the $\mathrm{T}_{\mathrm{arrive}}$ is more than 96 hours after the time of the initial forecast

where:

$\mathrm{H}_{\mathrm{forecast}}$ is the maximum significant wave height predicted for the limited duration voyage. It is to be extracted from the forecast at the time of planning the cargo stowage up to the time when the vessel leaves Open Water prior to entering the port of arrival. The forecast period is not to be less than 5 days.

The time of the initial forecast is to be taken as the most recent forecast prior to commencement of cargo planning operations.

1.3.6 When the ship departs, if the latest forecast is more severe than the earlier forecasts, then H_{SL} is to be taken as the maximum significant wave height from the latest forecast for the period up to the time the ship leaves Open Water prior to entering the port of arrival +24 hours for the planned voyage, if this exceeds H_{SL} from *Pt 3, Ch 14, 1.3 Application of the BoxMax(V,W,L) notation 1.3.5.*

1.3.7 The significant wave height used for the limited duration voyage should be recorded in the cargo plan information and the onboard lashing computer for the voyage. The ship specific weather dependent coefficients for a range of significant wave heights will be provided by Lloyd's Register as part of the **BoxMax(V,W,L)** notation.

1.3.8 Example of application of **BoxMax(V,W,L)**:

Scenario 1

Date	14 July	15 July	16 July	17 July	18 July	19 July
Voyage schedule	Planning commences at 14:00			Stowage and lashing Leaves quayside At 13:00 Enters Open Water at 16:00	Voyage 18 hours Leaves Open Water at 10:00 Arrive at quayside	

Forecast day 14 July @ 12:00 – initial forecast

Forecast time	12:00					
Time from initial forecast				T_{depart} = 76 hrs	T_{arrive} = 94 hrs	
Forecast wave height	3,3 m	3,3 m	3,7 m	3,7 m	3,5 m	3,3 m
$\mathbf{H_{forecast}}$	3,7 m					
$\mathbf{\Delta H_{forecast}}$ **(T_{arrive}>72h) (T_{arrive}<96h)**	1,0 m					
Limited duration H_{SL}	3,7 m + 1,0 m = 4,7 m rounded up to the next integer = 5 m					
Action	Plan lashing requirement with H_{SL} = 5 m					

Forecast day 15 July @ 12:00

Forecast time		12:00				
Forecast wave height		3,5 m	3,7 m	3,5 m	3,3 m	3,2 m
Action		Monitor weather forecast – no change in wave height expected				

Forecast day 16 July @ 12:00

Forecast time			12:00			
Forecast wave height			3,7 m	3,7 m	3,5 m	3,3 m
Action			Monitor weather forecast – no change in wave height expected			

Forecast day 17 July @ 12:00

Forecast time				12:00		
Forecast wave height				3,8 m	4,1 m	4,0 m
Action				Max forecast wave height increased to 4,1 m. 4,1 m is less than planning wave height of 5,0 m Voyage can be undertaken. Monitor latest forecast and actual sea state and consult Operational Guidance Document		

Forecast day 18 July @ 12:00

Forecast time					12:00	
Forecast wave height					4,2	4,0
Action					Monitor latest forecast and actual sea state and consult Operational Guidance Document	

Scenario 2

Date	14 July	15 July	16 July	17 July	18 July	19 July
Voyage schedule	Planning commences at 14:00			Stowage and lashing Leaves quayside At 13:00 Enters Open Water at 16:00	Voyage 18 hours Leaves Open Water at 10:00 Arrive at quayside	

Forecast day 14 July @ 12:00 – initial forecast

Forecast time	12:00					
Time from initial forecast				T_{depart} = 76 hrs	T_{arrive} = 94 hrs	
Forecast wave height	3,3 m	3,3 m	3,7 m	3,7 m	3,5 m	3,3 m
$\mathbf{H_{forecast}}$	3,7 m					
$\mathbf{\Delta H_{forecast}}$ **(T_{arrive}>72h) (T_{arrive}<96h)**	1,0 m					
Limited duration H_{SL}	3,7 m + 1,0 m = 4,7 m rounded up to the next integer = 5 m					

Action	Plan lashing requirement with H_{SL} = 5 m					
Forecast day 15 July @ 12:00						
Forecast time		12:00				
Forecast wave height		3,5 m	3,7 m	3,7 m	3,7 m	3,8 m
Action		Monitor weather forecast				
Forecast day 16 July @ 12:00						
Forecast time			12:00			
Forecast wave height			3,7 m	3,7 m	4,4 m	4,5 m
Action			Forecast indicates increasing waveheight (Maximum wave height still below $\boldsymbol{H_{\mathrm{SL}}}$ of 5 m) Consider reassessing lashing requirement with increased waveheight. Monitor weather forecast			
Forecast day 17 July @ 12:00						
Forecast time				12:00		
Forecast wave height				4,8 m	5,5 m	5,4 m
Action				Final forecast from $\mathrm{T_{depart}}$ to $\mathrm{T_{arrive}} + 24\ hours$ is higher than H_{SL}, hence cargo plan needs to be reassessed. Master needs to select an appropriate H_{SL} value, e.g. 6 m. Might result in delay to planned departure.		
Forecast day 18 July @ 12:00						
Forecast time					12:00	
Forecast wave height					5,5	5,4
Action					Monitor latest forecast and actual sea state and consult Operational Guidance Document	

Existing sub-Sections 1.3 to 1.5 have been renumbered 1.4 to 1.6.

~~1.3~~ 1.4 Plans and information required

~~1.3.3~~ 1.4.3 The Cargo Securing Manual is to include the following information:

(a) Representative lashing calculations based on two design *GM* values as follows:
- a lower design *GM* value of 2,5 per cent of the breadth *B*.
- an upper design *GM* value of 7,5 per cent of *B* for ships with a breadth less than 52 m and 10 per cent of *B* for ships where *B* ≥ 52 m.

(b) In addition to these two design *GM* values, actual *GM* values of the ship in the container loaded condition from the approved Trim and Stability Booklet or Loading Manual are to be included when the actual design *GM* values are outside the above range and the vessel does not have an approved onboard lashing program,

(c) For vessels with notation **BoxMax(V)** ~~or~~, **BoxMax(V,W)** **or BoxMax(V,W,L)** representative calculations based on applicable weather reduction factors are to be included in the Cargo Securing Manual.

(d) Lashing calculations in the Cargo Securing Manual are to be based on the maximum service speed V (*see Pt 3, Ch 1, 6.1 Principal particulars 6.1.10*). For vessels for which the voyage speed V_{d} may be less than the maximum service speed V, representative example calculations are to be included a lower value of voyage speed V_{d}.

~~1.5~~ 1.6 Symbols and definitions

(*Part only shown*)

~~1.5.1~~ 1.6.1 The following definitions are applicable to this Chapter, except where otherwise stated:

φ = design roll angle for container securing arrangements, in degrees

= $\mathrm{f_{HsR}}\varphi_{\mathrm{f}}$ but not less than 12 degrees

where

φ_{f} = $55 f_{\mathrm{BK}} e^{-0,025B}$ but need not to be taken greater than 30 degrees

If φ_{f} is less than ~~22~~ φ_{m}~~degrees~~:

φ_{f} = $55 f_{\mathrm{gm}} f_{\mathrm{v}} f_{\mathrm{BK}} e^{-0,025B}$ but is not to be taken greater than ~~22~~ φ_{m} ~~degrees~~

where

φ_{m}, the minimum unrestricted roll angle, in degrees, is to be taken as:
For ships with a breadth greater than 58 m:
= 22 degrees for *GM* values below 7,5 per cent of the breadth, *B*
= 18 degrees for *GM* values above 10 per cent of the breadth, *B*
for *GM* values between 7,5 and 10 per cent of the breadth, *B*, the minimum unrestricted roll angle is to be determined by linear interpolation.
For ships with a breadth less than 54 m:
= 22 degrees

For ships with breadth, *B*, between 54 m and 58 m, the minimum unrestricted roll angle is to be determined by linear interpolation.

f_v = $0,175V_d - 2,2$ but is not to be taken less than 1,0

f_{gm} = $\dfrac{7,5GM}{B} + 0,6$ but is not to be taken less than 1,0

V_d is the voyage speed, in knots. V_d is the maximum sailing speed for the intended voyage for which the container stowage arrangements are being designed.

Note If the roll angle φ_f for container securing arrangements is less than 22 degrees for a *GM* value of 5 per cent of the breadth, *B*, then the following information is to be provided to the Master as an Operational Guidance Document and is also to be included in the Trim and Stability Booklet or the Loading Manual. Presentation of the predicted roll angles taking into account the following parameters:

- GM value,
- Ship's speed up to the maximum speed,
- Ship to wave heading,
- Wave height.

This information is to be provided for the normal operating design draught. If it is expected that the ship will operate with a wide range of draughts, then the predicted roll angles should be provided for additional draughts. The roll angle prediction should be determined on the following basis: probable maximum roll angle in 3 hours based on a 1-year return period for the wave heights, calculated using short-term statistical techniques, a cosine^2 heading probability and roll damping values appropriate for the predicted roll angles. The roll angle data should include the effects of synchronous rolling to the waves and also parametric rolling. Prediction of parametric roll angles is very difficult and it is sufficient to show the headings and speeds where parametric rolling is likely for each *GM* value. If such information is not provided, then the design roll angle φ_f for container securing arrangements is to be taken as not less than ~~22~~ φ_m degrees.

~~F_{HsW} = weather dependent factor for whipping acceleration~~

~~= 1,0 for unrestricted worldwide service~~

C_{p1} = hull whipping factor

= $1 + f_{MC}f_{wh}$~~f_{HsW}~~

z_c = vertical centre of gravity of a container above the keel, in metres

c_{vcg} = vertical location of the centre of gravity of the container measured positive upward from the bottom of the corner castings. To be taken at 33 percent of the height of the container. Other values of c_{vcg} will be specially considered.

x_i = longitudinal coordinate of the centre of gravity of container *i*, in metres, from O_m measured positive forwards in ship coordinate system, *see Figure 14.1.1 Diagrammatic representation of symbols*

= $x_c - x_{om}$

y_i = transverse coordinate of the centre of gravity of container *i*, in metres, from O_m measured positive to port in ship coordinate system, *see Figure 14.1.1 Diagrammatic representation of symbols*

z_i = vertical coordinate of the centre of gravity of container *i*, in metres, from O_m measured positive upwards in ship coordinate system, *see Figure 14.1.1 Diagrammatic representation of symbols*

= $z_c - z_{om}$

■ *Section 5*
Container securing arrangements for stowage on exposed decks without cell guides

5.4 Containers in more than two tiers

5.4.13 No lashings are to be applied to the ends of a 45 ft, 48 ft or 53 ft container if stowed on top of a shorter unit.

■ *Section 7*
Container securing arrangements for stowage using cell guides

7.3 Carriage of 20ft containers in 40ft cell guides in holds

7.3.3 Where it is desired to stow 20 ft containers without external support at the mid-bay location with or without 40 ft overstow, so-called 'mixed stowage' arrangements meeting the following requirements are applicable:

(a) Maximum homogeneous container weights for 20 ft containers stowed in cell guides with no 40 ft containers overstowed can be derived from *Table 14.7.1 Maximum container weights of ISO 1496-1:1990 20 ft containers stowed in 40 ft cell guides with no overstow* ~~depending on the transverse acceleration and the number of tiers in the stack.~~

(b) ~~Maximum homogeneous container weights for 20 ft containers stowed in cell guides with at least one 40 ft container overstowed can be derived from *Table 14.7.3 Maximum container weights of ISO 1496-1:1990 20 ft containers stowed in 40 ft cell guides with overstow*, depending on the transverse acceleration and the number of tiers in the stack.~~ Maximum homogeneous container weights for 20 ft containers stowed in cell guides with one or more 40 ft containers overstowed can be derived from:

   (i) *Table 14.7.2 Maximum containers weights W_h of 20 ft containers stowed in 40 ft cell guides with overstow, diagonal stacking cone arrangement*

(ii) *Table 14.7.3 Maximum container weights W_h of 20 ft containers stowed in 40 ft cell guides with overstow, other stacking cone arrangements*

(c) ~~Table 14.7.1 Maximum container weights of ISO 1496-1:1990 20 ft containers stowed in 40 ft cell guides with no overstow to Table 14.7.2 Maximum container weights of ISO 1496-1:1990 20 ft containers stowed in 40 ft cell guides with overstow have been derived on the basis of all containers in a stack having the same homogeneous weight. Where it is intended to carry non-homogeneous mixed stowage stacks, containers heavier than specified in *Table 14.7.1 Maximum container weights of ISO 1496-1:1990 20 ft containers stowed in 40 ft cell guides with no overstow* to *Table 14.7.2 Maximum container weights of ISO 1496-1:1990 20 ft containers stowed in 40 ft cell guides with overstow* can be loaded in the lower tiers provided that the total stack weight derived from the Tables is not exceeded. Furthermore, no container having a weight in excess of the maximum weight stated in the Tables is to be stowed on top of a lighter container. However, the total accumulated stack weight derived from the above mentioned Tables may be increased by loading the lowest container in the stack up to its maximum rated weight.~~

All inhold mixed stowage tables have been derived on the basis of all 20 ft containers having the same weight. However it is acceptable to carry non-homogeneous stacks provided the following two conditions are met:

(i) 20 ft containers heavier than specified in the weight W_h can be loaded provided that the average container weight excluding the lowest container in the stack does not exceed W_h, i.e.

$$\sum_2^N W_i \leq (N-1)W_h$$

(ii) The total moment of 20 ft containers in a stacks about the base is not to be greater than the moment exerted by an equivalent homogeneous stack of weight W_h, i.e.

$$\sum_2^N W_i c_i (i-1) \leq (N-1)W_h \frac{c_a N}{2}$$

where:

W_i weight of container *i*.

c_i height of container *i*.

W_h is the homogeneous container weight as determined from *Table 14.7.1 1 Maximum container weights W_h of 20 ft containers stowed in 40 ft cell guides with no overstow*, *Table 14.7.2 Maximum containers weights, W_h of 20 ft containers stowed in 40 ft cell guides with overstow, diagonal stacking cone arrangement* or *Table 17.7.3 Maximum container weights W_h of 20 ft containers stowed in 40 ft cell guides with overstow, other stacking cone arrangement* as applicable.

c_a average height of the 20 ft containers in the stack.

N Number of 20 ft containers.

(d) The weight of the lowest container in the stack may be increased to its rated value.

(e) The force in the corner post in the lowest container is not to exceed the permissible compression value given in *Table 14.9.6 Allowable forces in containers in stacks with the same base size*. The force is to be determined by:

$$V = -\frac{a_z(W_{40s}+W_{20s-1})}{4}$$

where:

V is the compressive force in the corner post

W_{40s} is the total weight of the 40 ft containers, in tonnes

W_{20s-1} is the total weight of the 20 ft containers excluding the weight of the lowest container, in tonnes

a_z is the maximum vertical acceleration, *see Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.5*

~~(d)~~ (f) Means are to be provided to prevent transverse sliding of the bottom of the stacks of 20 ft containers at the mid-bay position. This is to be in the form of permanently attached chocks at the inner bottom or equivalent. The design clearance is to be the same as for the cell guides and in accordance with *Pt 3, Ch 14, 7.2 Arrangement and construction 7.2.4*.

~~(e)~~ (g) ~~Stacking cones are to be fitted at each corner between tiers of the 20 ft containers to prevent transverse and longitudinal sliding. In addition, where a 40 ft container is required to be stowed above 20 ft containers, stacking cones are to be fitted at the ends of the 40 ft container between the 40 ft container and the 20 ft containers below.~~ 20 ft containers stowed with no stacking cones are to be restrained to avoid transverse movement, e.g. all containers at the same tier height in a bay are to be of the same height and structural constraints between the containers and the hull are to be provided.

~~(f)~~ (h) The 20 ft containers are to have closed steel walls and top (no open frame containers, e.g. tank or bulk containers).

~~(g) The orientation of the containers is to be such that all front ends or door ends are facing in one direction.~~

~~(h) Cones are to be fitted on the inner bottom in way of the cell guides to restrain container movement in the longitudinal direction.~~

~~(i) The containers are to be stowed in the hold in block stowage. In general, free standing stacks due to adjacent empty stacks are to be avoided.~~

Proposals for stowage arrangements other than the above will be individually considered and are to be accompanied by supporting calculations.

(*Part only shown*)

Table 14.7.1 Maximum container weights W_h of ~~ISO 1496-1:1990~~ 20 ft containers stowed in 40 ft cell guides with no overstow

Lowest tier transverse acceleration (= a_y/g), *see Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.5*	Maximum homogeneous container weights, in tonnes
Note 1. Linear interpolation is to be used to determine intermediate values. ~~Note 2. The maximum container weight should not exceed the rated weight of the container~~ **Note** 2**.** 40 ft overstow containers not included in the number of tiers. **Note** 3. Maximum container weights for transverse acceleration and number of tiers outside of those presented will be specially considered. **Note** 4. The maximum container weight should not exceed the rated weight of the container.	

Note 5. For mixed box height stowage, the weight is to be reduced as follows:

$W_h = W_h \frac{2.438}{c_a}$

Where:

c_a is the average height of the 20 ft containers

Existing Table 14.7.2 Maximum container weights of ISO 1496-1:1990 20 ft containers stowed in 40 ft cell guides with overstow has been deleted in its entirety.

Table 14.7.2 Maximum containers weights, W_h of 20 ft containers stowed in 40 ft cell guides with overstow, diagonal stacking cone arrangement

Lowest tier transverse acceleration (= a_y/g), *see Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers* 8.2.5	Maximum homogeneous container weights, in tonnes (number of 20 ft containers)							
	4 tiers and fewer	5 tiers	6 tiers	7 tiers	8 tiers	9 tiers	10 tiers	11 tiers
0,20	30,5	30,5	30,5	29,2	28,2	24,8	22,6	21,0
0,21	30,5	30,5	30,5	29,2	28,2	24,8	22,5	20,7
0,22	30,5	30,5	30,5	29,2	28,2	24,8	22,4	20,5
0,23	30,5	30,5	30,5	29,2	28,2	24,8	22,3	20,3
0,24	30,5	30,5	30,5	29,2	28,2	24,8	22,1	20,0
0,25	30,5	30,5	30,5	29,2	28,2	24,8	22,0	19,8
0,26	30,5	30,5	30,5	29,2	28,2	24,7	21,9	19,6
0,27	30,5	30,5	30,5	29,1	28,0	24,6	21,8	19,6
0,28	30,5	30,5	30,5	29,0	27,8	24,4	21,7	19,5
0,29	30,5	30,5	30,5	28,9	27,7	24,3	21,6	19,4
0,30	30,5	30,5	30,5	28,8	27,5	24,2	21,5	19,3
0,31	30,5	30,5	30,5	28,7	27,4	24,0	21,4	19,2
0,32	30,5	30,5	30,5	28,6	27,2	23,9	21,2	19,1
0,33	30,5	30,5	30,5	28,6	27,1	23,8	21,1	19,0
0,34	30,5	30,5	30,5	28,5	27,0	23,7	21,0	18,8
0,35	30,5	30,5	30,5	28,2	26,5	23,4	20,9	18,9
0,36	30,5	30,5	30,5	27,9	26,0	23,1	20,8	18,9
0,37	30,5	30,5	30,5	27,7	25,5	22,8	20,6	18,8
0,38	30,5	30,5	30,5	27,4	25,1	22,4	20,2	18,4
0,39	30,5	30,5	30,5	27,2	24,7	22,0	19,8	18,1
0,40	30,5	30,5	30,5	26,9	24,3	21,6	19,4	17,7
0,41	30,5	30,5	30,5	26,7	23,9	21,2	19,1	17,4
0,42	30,5	30,5	30,5	26,5	23,6	20,9	18,8	17,0
0,43	30,5	30,5	30,5	26,4	23,3	20,6	18,4	16,7
0,44	30,5	30,5	30,5	26,2	23,0	20,3	18,1	16,4
0,45	30,5	30,5	30,5	26,1	22,8	20,0	17,9	16,1
0,46	30,5	30,5	29,8	25,7	22,6	19,8	17,6	15,8
0,47	30,5	30,5	29,0	25,2	22,3	19,5	17,2	15,3
0,48	30,5	30,5	28,1	24,4	21,6	18,9	16,7	14,9
0,49	30,5	30,5	27,2	23,6	20,9	18,3	16,3	14,7
0,50	30,5	30,5	26,4	22,8	20,1	17,8	16,0	14,5
0,51	30,5	30,4	25,5	22,0	19,4	17,3	15,7	14,3
0,52	30,5	29,3	24,6	21,2	18,7	16,9	15,4	14,3
0,53	30,5	28,3	23,7	20,4	18,0	16,5	15,3	14,3
0,54	30,5	27,2	22,8	19,6	17,2	16,1	15,1	14,3
0,55	30,5	26,2	21,9	18,8	16,5	15,6	14,9	14,4

Note 1. Linear interpolation is to be used to determine intermediate values.

Note 2. 40 ft overstow containers not included in the number of tiers

Note 3. Maximum container weights for transverse acceleration and number of tiers outside of those presented will be specially considered.

Note 4. The maximum container weight should not exceed the rated weight of the container.

Note 5. For mixed box height stowage, the weight is to be reduced as follows:

$W_h = W_h \frac{2.438}{c_a}$

where

c_a is the average height of the 20 ft containers

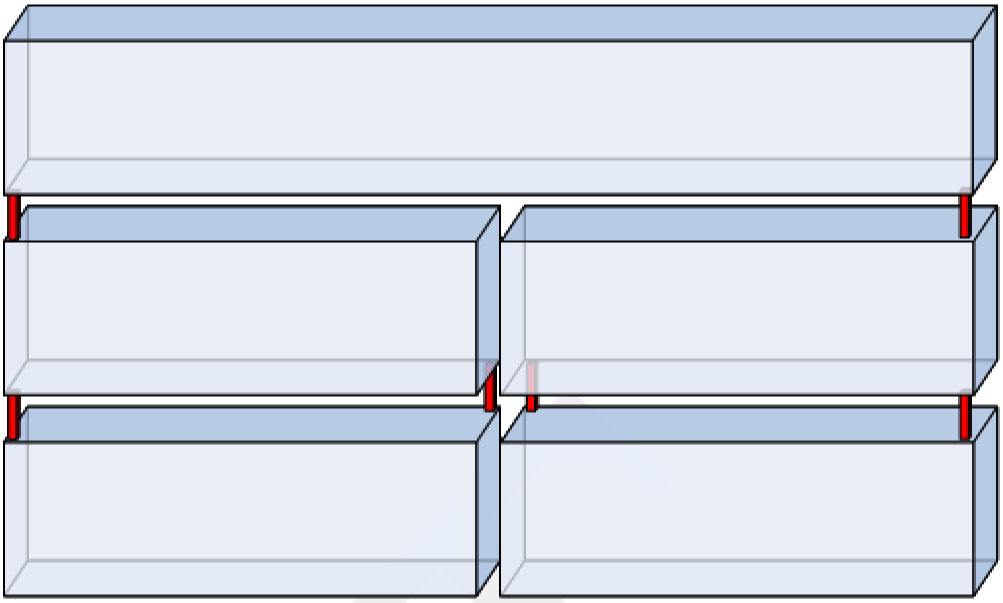


Figure 14.7.1 Diagonal stacking cone arrangement

Table 14.7.3 Maximum container weights W_h of 20 ft containers stowed in 40 ft cell guides with overstow, other stacking cone arrangement

Lowest tier transverse acceleration (= a_y/g), *Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers* 8.2.5	Maximum homogeneous container weights, in tonnes					
	3 tiers	4 tiers	5 tiers	6 tiers	7 tiers	8 tiers
0,400	24,0	24,0	24,0	19,6	17,1	15,2
0,410	24,0	24,0	23,3	19,2	16,8	14,9
0,420	24,0	24,0	22,5	18,9	16,5	14,7
0,430	24,0	24,0	21,8	18,6	16,2	14,4
0,440	24,0	24,0	21,2	18,3	15,9	14,1
0,450	24,0	24,0	20,8	18,0	15,7	13,9
0,460	24,0	24,0	20,5	17,7	15,4	13,6
0,470	24,0	24,0	20,2	17,3	15,1	13,3
0,480	24,0	23,9	19,9	17,0	14,8	13,1
0,490	24,0	23,6	19,6	16,7	14,5	12,8
0,500	24,0	23,2	19,3	16,4	14,2	12,5
0,510	24,0	22,9	18,9	16,1	13,9	12,2
0,520	24,0	22,5	18,6	15,7	13,6	12,0
0,530	24,0	22,3	18,3	15,4	13,3	11,7
0,540	24,0	22,1	18,1	15,1	13,0	11,4
0,550	24,0	21,8	17,9	14,8	12,8	11,2

Note 1. Linear interpolation is to be used to determine intermediate values.

Note 2. 40 ft overstow containers not included in the number of tiers.

Note 3. Maximum container weights for transverse acceleration and number of tiers outside of those presented will be specially considered.

Note 4. The maximum container weight should not exceed the rated weight of the container.

Note 5. For mixed box height stowage, the weight is to be reduced as follows:

$W_h = W_h \frac{2.438}{c_a}$

where

c_a is the average height of the 20 ft containers

■ *Section 8*

Determination of forces for container securing arrangements

8.2 Ship motion, wind and green sea forces acting on containers

8.2.4 The individual force components for each Motion Case due to gravity, ship motions, wind and green seas acting on a container *i* are to be determined as follows, *see Figure 14.1.1 Diagrammatic representation of symbols* and *Figure 14.9.1 Force derivation at one end of a three-tier stack*:

H_{Di} = force acting on container *i* in kN in transverse direction parallel to deck, positive to port

= $W\ a_{\text{y}}$

J_{Di} = force acting on container *i* in kN in transverse direction parallel to deck, positive forward

= $W\ a_{\text{x}}$

P_{Di} = force acting on container *i* in kN in vertical direction normal to deck, positive upward

= $W\ a_{\text{z}}$

Q_{Di} = wind force acting on exposed container *i* in kN in transverse direction parallel to deck, positive to port

= ~~$C_{wf}\ b\ c_i V_w^2\ cos^2(C_{yG}\varphi)10^{-4}$~~

= $Q_{\text{DS}i}Q_{\text{DMi}}$

where

Q_{DMi} = wind force magnitude acting on exposed container *i* in kN in transverse direction parallel to deck

= $0{,}5\ b\ c\ \rho_a\ C_{roll}\ C_z\ C_{wh}V_{wh}^2 10^{-3}$

where

C_{roll} wind force coefficient to include effect of roll angle

= $\left(\frac{1}{1+0{,}026|C_{yG}|\varphi} + 0{,}65\right)$

ρ_a density of air in kg/m^3 is to be taken as

= 1,204

C_Z wind force height distribution coefficient

= $\left(1 - \frac{z_{ci}-z_{bc}}{z_{tc}-z_{bc}}\right)^{0{,}25}$

V_{wh} mean wind speed over the stack in m/s

= $0{,}63V_w \frac{z_{tc}^{1{,}11}-z_{bc}^{1{,}11}}{z_{tc}-z_{bc}}$

z_{bc} height above moulded draught, T$_{\text{c}}$, of the underside of the lowest container in the outermost stack, in m
z_{tc} height above moulded draught, T$_{\text{c}}$, of the top of the highest container in the stack under consideration, in m
z_{ci} height above moulded draught, T$_{\text{c}}$, of the centre of the side wall of container *i*, in m
C_{wh} wind heading coefficient, given in *Table 14.8.1 Wind heading coefficient* C_{wh}
C_{yG} transverse acceleration motion combination factor C_{yG}, given in *Table 14.8.3 Motion Combination Factors (MCFs)*
Other symbols are defined in *Section 1.6 Symbols*.

Q_{DSi} = Wind force direction coefficient

= -1 if $H_{Di} \leq 0\text{kN}$

= 1 if $H_{Di} > 0\text{kN}$

~~where~~

~~C_{wf} is given in *Table 14.8.1 Wind force coefficient* C_{wf} and C_{yG} is given in *Table 14.8.3 Motion Combination Factors (MCFs)*~~

~~**Note** 1. Q_{Di} is only to be applied when Q_{Di} will increase the magnitude of the transverse force H_{Di}.~~

~~**Note** 2. *See also Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.6* to *Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.8*.~~

(*Part only shown*)

Table 14.8.1 Wind ~~force~~ heading coefficient $C_{\text{w}\cancel{\text{f}}\text{h}}$

	Wind ~~force~~ heading coefficient ~~C_{wf}~~C_{wh}	
~~Motion case~~ ~~*See* Note 1~~	~~Incoming wave from port (1P and 2P cases)~~	~~Incoming wave from starboard (1S and 2S cases)~~
Motion case *see* Note 1	Only applied to the ~~port~~ exposed ~~faces~~ side walls of containers as defined in *Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.7* and *Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.8*~~,~~ ~~*see* Note 3~~	~~Only applied to the starboard exposed faces of containers, *see* Note 3~~
MC1, *see* Note 2	0	~~0~~
MC2	~~-8,25~~ 1,00	~~8,25~~
MC3	~~-7,18~~ 0,866	~~7,18~~
MC4	~~-7,18~~ 0,866	~~7,18~~

MC5	~~-7,18~~ 0,866	~~7,18~~
MC6	~~-8,25~~ 1,00	~~8,25~~

Note 1. For definition of Motion Cases, *see Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.7*.
Note 2. No wind loads are to be applied to Motion Case MC1.
~~**Note** 3. For definition of exposed faces, *see Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.7.*~~

Existing Tables 14.8.2 and 14.8.3 have been renumbered 14.8.3 and 14.8.4.

8.2.6 Wind forces are to be applied to the outer faces of the outermost container stack in accordance with *Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.4*. Wind forces may also need to be applied to inboard stacks in accordance with *Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.7*. The wind forces are to be taken as acting in the athwartships direction. Only positive forces of wind pressure are to be applied; suction forces need not be included. *See Figure 14.8.1 Application of wind forces.*

~~8.2.7 Wind forces are to be taken as acting athwartships on the exposed faces of the container stack. Where the air gap between adjacent rows of containers does not exceed one metre, wind forces on the adjacent inner stack may be taken as zero. Where the air gap is 5 m or more, the adjacent inner stack is to be treated as fully exposed. Wind forces on the inner stack for intermediate air gaps may be obtained by linear interpolation, *see Figure 14.8.1 Application of wind forces*.~~

8.2.7 Wind forces are to be applied to containers in inboard stacks if the centre of the windward side wall of the container is above the wind shear line, *see Figure 14.8.1 Application of wind forces*. The wind shear line is to be taken at an angle of 35 degrees to the horizontal and passing through the upper corner of the uppermost container of any windward stack, *see Figure 14.8.1 Application of wind forces*. The roll angle is to be ignored in the assessment of the wind shear line. The wind force is to be derived in accordance with *Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.4* but *see also Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.8*.

Hence wind forces are to be applied to containers in inboard stacks if:

$$z_{\text{ci}} > z_{\text{ws}} + (|y_{\text{ws}} - y_{\text{ci}}|)\tan(35)$$

Where:

z_{ci} is the vertical position of the centre of the windward side wall of container *i* of the stack under consideration
y_{ws} is the transverse position of the windward top corner of the uppermost container of the stacks windward of the stack under consideration
z_{ws} is the vertical position of the windward top corner of the uppermost container of the stacks windward of the stack under consideration
y_{ci} is the transverse position of the centre of the windward side wall of container *i* of the stack under consideration

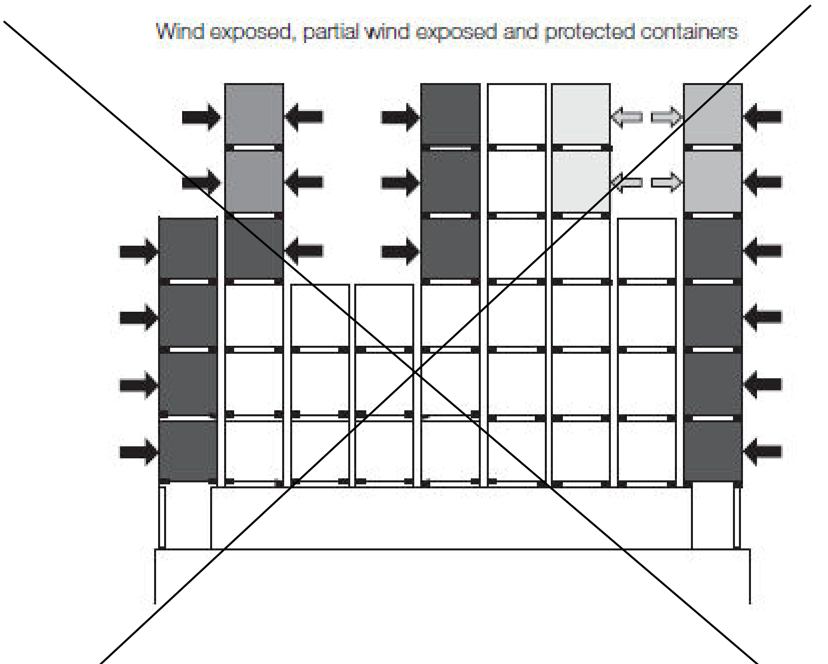
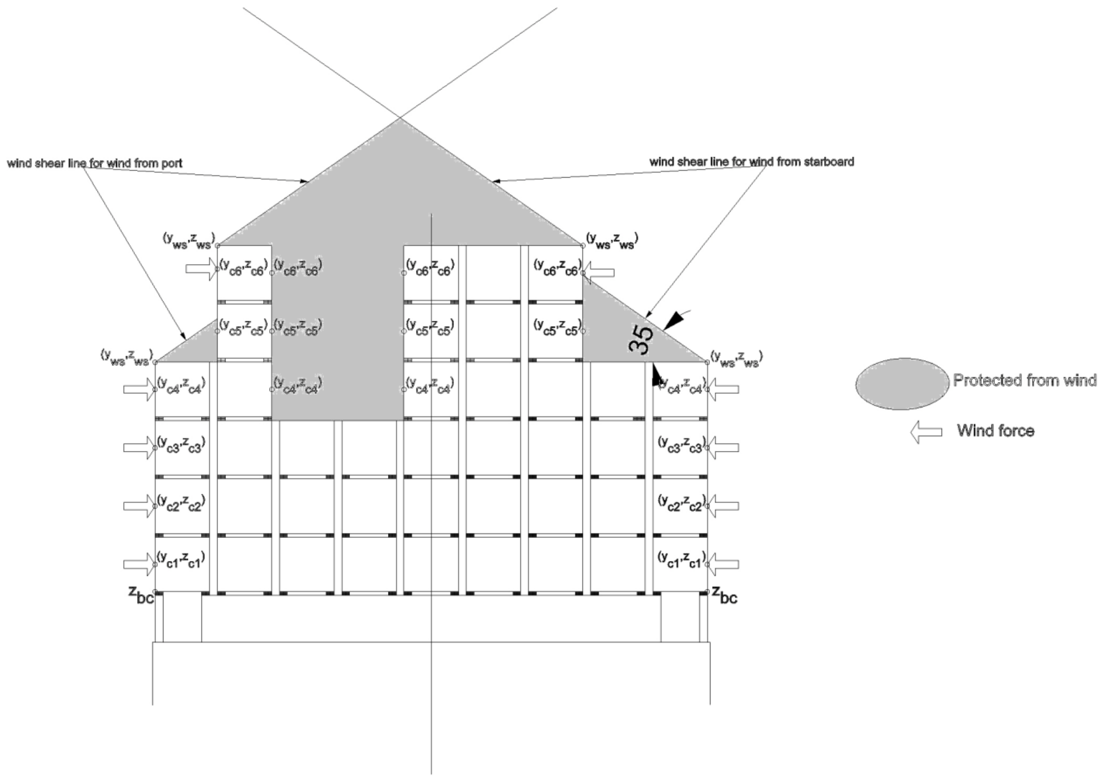


Figure 14.8.1 Application of wind forces



Note. The formula in *Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.7* compares points at the container base and centre. The drawing compares points at the side. Both comparisons yield the same result.

Figure 14.8.1 Application of wind forces

8.2.8 A container is considered protected from wind in the transverse direction or from green sea loads in the longitudinal or transverse direction if~~:~~

- ~~another container extends above mid-height of the container, protecting it from where the load originates, or~~
- an effective breakwater or similar extends above mid-height of the container.

~~Note for the purpose of protection, a 20ft or 40ft container will fully protect an inboard 40ft or 45ft container.~~

8.2.9 A container is considered partially protected from wind if an outboard container partially shields an inboard container as follows:

- An outboard 40ft container is considered to fully protect a longer inboard container.
- An outboard 20ft container is considered to partially protect a longer inboard container from wind. In this case the full wind force is to be applied over the exposed portion of the longer inboard container when the overlap is more than 3m. The resulting wind force is to be applied solely to the end wall of the exposed portion.

Existing paragraph 8.2.9 is to be renumbered 8.2.10.

■ *Section 9*
Strength of container securing arrangements

9.1 General

9.1.4 The container orientation is to follow the cargo securing manual, however, if unknown the container door end is assumed to face aft.

Existing paragraphs 9.1.4 has been renumbered 9.1.5.

~~9.1.5 For containers that are stowed in the fore and aft direction, it is sufficient to evaluate the securing arrangements based on assessment of the transverse and vertical loads acting on the containers. For containers that are stowed athwartships, the longitudinal forces will also need to be taken into account.~~

9.1.6 For containers that are stowed in the fore and aft direction, it is sufficient to calculate the forces in the lashing rods based on assessment of the transverse and vertical loads acting on the containers. The vertical forces in the corner posts are to include the effects of transverse and longitudinal loads acting on the containers.

9.1.7 For containers that are stowed athwartships, the transverse, longitudinal and vertical loads acting on the containers will need to be taken into account in calculating the forces in the lashing rods. The vertical forces in the corner posts are to include the effects of transverse and longitudinal loads acting on the containers. The approach to be adopted should be agreed with Lloyd’s Register.

9.2 Forces applied to each container

~~9.2.1 The applied forces due to ship motion and green sea loads acting on each container in the stack in accordance with *Pt 3, Ch 14, 8 Determination of forces for container securing arrangements* are illustrated in *Figure 14.9.1 Force derivation at one end of a three-tier stack* and are assumed to be divided equally between the walls of the container, as follows:~~

~~H_i = transverse force on each end wall = $\frac{H_{Di}+H_{Gi}}{2}$ kN~~

~~J_i = longitudinal force on each side wall = $\frac{J_{Di}+J_{Gi}}{2}$ kN~~

~~P_i = vertical force on each bottom corner casting = $\frac{P_{Di}+P_{Gi}}{4}$ kN~~

~~The subscript *i* refers to any particular container. *See also Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.9* to *Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.11*~~

~~9.2.2 The applied forces due to wind acting on each container in the stack in accordance with *Pt 3, Ch 14, 8 Determination of forces for container securing arrangements* are illustrated in *Pt 3, Ch 14, 9.3 Total resulting forces in an unlashed stack 9.3.1* and are assumed to be divided equally between the walls of the container. The wind force is reduced by green sea force if a green sea force is applied, *see Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.9* to *Pt 3, Ch 14, 8.2 Ship motion, wind and green sea forces acting on containers 8.2.11*.~~

~~Q_i = wind force on each end wall = $\frac{Q_{Di}-H_{Gi}}{2}$ kN~~

~~9.2.3 Forces H i and Ji are assumed to act at one third of the height of the container above its base. The default distribution of forces Hi and Ji is thus as follows:~~

- ~~$\frac{H_i}{3} (or\ \frac{J_i}{3})$ acting at the top of the container, and~~
- ~~$\frac{2H_i}{3} (or\ \frac{2J_i}{3})$ acting at the bottom.~~

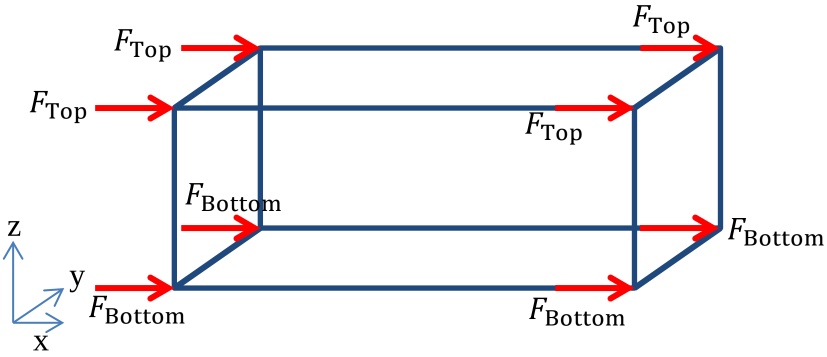
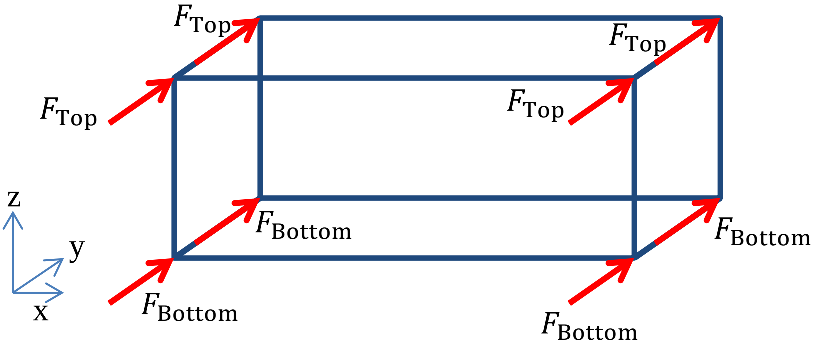
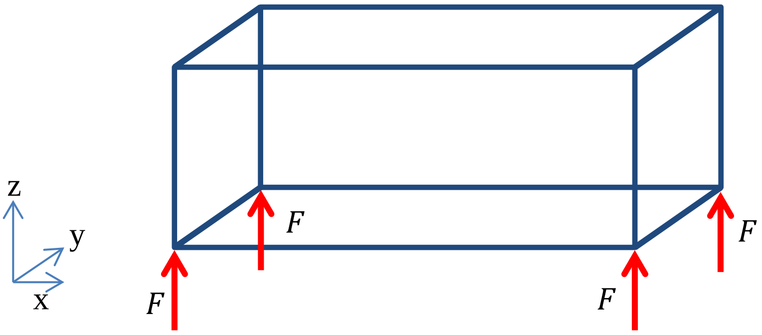
~~9.2.4 Wind force is assumed to be uniformly distributed over the side of the container and is therefore divided equally between the top and bottom of the container.~~

9.2.1 Forces due to acceleration, green water and wind in accordance with *Pt 3, Ch 14, 8 Determination of forces for container securing arrangements*, are to be applied as follows:

- Acceleration forces are to be calculated about the centre of gravity of the container.
- Vertical acceleration forces and self-weight are to be distributed to the four bottom corner castings.
- Vertical, transverse and longitudinal green sea loads act uniformly over the exposed panel of the container.
- Wind loads act uniformly over the exposed panel of the container.

9.2.2 *Table 14.9.1 Acceleration force application* shows a method to apply the forces to a container, assuming centre of gravity of the container is to be taken as half way along its length, midway between the port and starboard wall, and c_{VCGi} off the container floor.

Table 14.9.1 Acceleration Force Application

Acceleration Force	Figure
(a) Longitudinal acceleration force	 F_{Top} F_{Top} F_{Top} F_{Top} F_{Bottom} F_{Bottom} F_{Bottom} F_{Bottom} z y x where $F_{\mathrm{Top}} = \frac{J_{\mathrm{Di}}}{4} \cdot \frac{c_{\mathrm{VCGi}}}{c_i}$ $F_{Bottom} = \frac{J_{\mathrm{Di}}}{4} \cdot \left(1 - \frac{c_{\mathrm{VCGi}}}{c_i}\right)$
(b) Transverse acceleration force	 F_{Top} F_{Top} F_{Top} F_{Top} F_{Bottom} F_{Bottom} F_{Bottom} F_{Bottom} z y x where $F_{\mathrm{Top}} = \frac{H_{\mathrm{Di}}}{4} \cdot \frac{c_{\mathrm{VCG}i}}{c_i}$ $F_{\mathrm{Bottom}} = \frac{H_{\mathrm{Di}}}{4} \cdot \left(1 - \frac{c_{\mathrm{VCGi}}}{c_i}\right)$
(c) Vertical acceleration force	 where $F = \frac{P_{\mathrm{Di}}}{4}$
Note The force application assumes the centre of gravity of the container is to be taken as half way along its length, midway between the port and starboard wall and c_{VCGi} off the container floor.	

Existing sub-Sections 9.3, 9.4, 9.5 and 9.6 have been deleted in their entirety except where noted.

9.3 Analysis of the container stack

9.3.1 LR’s Guidance Notes for *Calculation Procedure of Container Stack Analysis* describes a methodology that complies with these requirements.

9.3.2 The application of ship motion and environmental loads will induce forces in the container boxes and lashing devices which result in distortion of the container stack. The key structural items resisting this distortion are as follows:

- The shear stiffness of the container end and side panels;
- The axial stiffness of the container corner posts;
- The stiffness of the lashing devices, including lashing bridge structure, when present;
- Under certain conditions and lashing arrangements, the twistlock can experience lifting forces which result in increased stack distortion.

All these aspects need to be considered in the stack analysis.

9.3.3 The forces in the containers, twistlocks and lashing devices are calculated from the stack distortion. Using the forces applied to the stack in *9.2 Forces applied to each container* and the stiffness of the stack, the overall stack deformation is calculated using the standard force-displacement equations. Non-linearity of the system as a consequence of twistlock separation and lashing rods is to be considered in evaluating the deformation. The inclusion of twistlock separation and corner post stiffness results in an increase in the loads in the lashing devices. The inclusion of a lashing bridge structure significantly affects the support a lashing device can provide for the stack and hence must be considered.

9.3.4 The overall distortion behaviour of a container is a combination of its shear stiffness and corner post stiffness. A container is to be modelled as a combination of shear only panels representing the walls, and rod elements representing the corner posts and horizontal frame structures. The shear stiffness of the container walls is to be taken as specified in *Table 14.9.2 Shear spring stiffness of container walls*. The area and Young’s Modulus of the corner posts and horizontal frame members is to be taken as specified in *Table 14.9.3 Container post properties*.

Table 14.9.2 Shear spring stiffness of container walls

Container height	Door end kN/mm	Closed end kN/mm	Side wall kN/mm
2,438 m (8 ft)	3,7	16,7	6,1
2,591 m (8 ft 6 in)	3,5	15,4	5,7
2,743 m (9 ft)	3,3	14,3	5,4
2,896 m (9 ft 6 in)	3,2	13,3	5,1

Table 14.9.3 Container post properties

Property	Corner post properties	Horizontal post properties
Effective Area	3800 mm^2	2000 mm^2
Young’s Modulus	206 kN/mm^2	206 kN/mm^2

9.3.5 Lashing devices are to be taken into account and their properties modelled to capture their behaviour. These include but are not limited to lashing rods and shore devices.

9.3.6 Lashing rods are to be modelled using tension only rod elements. Elongation may be determined by reference to an effective cross-sectional area and an effective modulus of elasticity of the lashing (allowance for straightening and stretching), which in the absence of actual test values, is to be taken as specified in *Table 14.9.4 Effective modulus of elasticity of lashing devices*.

9.3.7 Lashing rod stiffness, k_{Lr}, in kN/mm may be derived as follows:

$$k_{Lr} = \frac{E_r A_r}{l_r}$$

where,

E_r = effective modulus of elasticity, in kN/mm^2, *see Table 14.9.4 Effective modulus of elasticity of lashing devices*
A_r = cross sectional area of lashing device, in mm^2
l_r = length of lashing rod device, in mm

9.3.8 For external and internal para-lash arrangements, each lashing rod is to be individually modelled and connected to the relevant container casting.

9.3.9 Other lashing rod arrangements, e.g. an internal para-lash with load equaliser arrangements, will need to be specially considered.

Table 14.9.4 Effective modulus of elasticity of lashing devices

Lashing equipment	Effective modulus of elasticity
Steel rod lashings of hook type,	98 kN/mm^2

including turnbuckle	
Short (one tier) steel rod lashings (knob type), including turnbuckle and lashing eyes	140 kN/mm^2
Long (two tier) steel rod lashings (knob type), including turnbuckle and lashing eyes	175 kN/mm^2
Steel wire rope lashings	90 kN/mm^2
Steel chain lashings (based on the nominal diameter of the chain)	80 kN/mm^2
Adjustable tension/compression buttress	120 kN/mm^2
Aluminium or other materials	To be specially considered

9.3.10 Any other element introducing flexibility into the structure between the lashing point and the base of the container stack is to be evaluated and taken into account. Examples of this could be flexibility of the lashing bridge, sliding of a hatch cover or torsional deformations of the hull.

9.3.11 Where lashing devices are attached to a lashing bridge, the lashing bridge transverse stiffness is to be taken into account and may be modelled as an additional rod element. For lashing bridge designs with multiple lashing platforms, a lashing bridge rod element is required for each platform. All the lashing bridge rod elements are to be connected in series. The bottom of the lashing bridge can be assumed to be rigidly fixed.

The transverse spring stiffness of the lashing bridge is to be determined/verified using the ShipRight SDA Procedure for the Assessment of Container Ship Lashing Bridge Structures. Where the lashing bridge design is not available, each lashing platform may be modelled with a rod with a transverse spring stiffness ($\mathrm{k_{lbyi}}$) calculated from the following:

$$k_{\mathrm{lbyi}} = \frac{50}{H_{\mathrm{lbi}}} kN/mm$$

where,

H_{lbi} is the height of lashing bridge tier *i*, taken in m, *see Figure 14.9.1 Lashing bridge transverse spring stiffness*

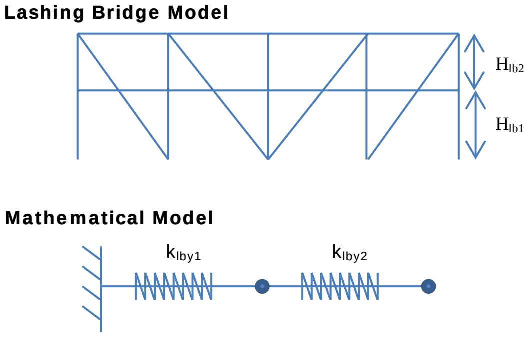
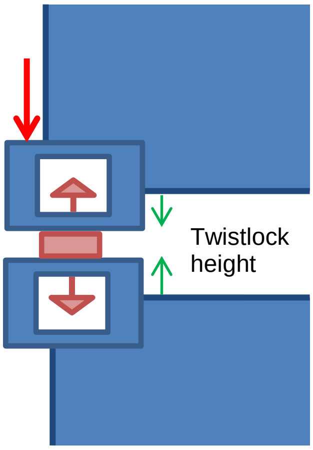
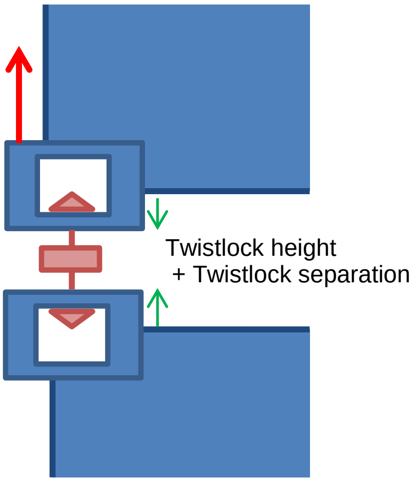
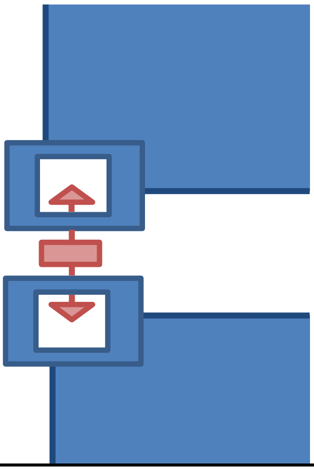


Figure 14.9.1 Lashing bridge transverse spring stiffness

9.3.12 Inherent in the twistlock design is a need for play in order to be able to fit the device. This play allows easy installation of the twistlocks, but this also means that vertical lifting of the top container occurs before the twistlock comes in to tension. Twistlocks therefore have three states, *see Table 14.9.5 Twistlock separation and states.* This vertical lifting distance is referred to as twistlock separation. If this separation occurs then it can significantly increase the transverse stack deformation and the forces in the lashing devices. The assessment of the effects of twistlock separation is particularly critical for external lashing arrangements.

Table 14.9.5 Twistlock separation and states

State	Figure	Description
Twistlock closed		Twistlock closed and in compression. The distance between the container castings is equal to the twistlock height.
Twistlock open		Twistlock open and in tension. The distance between the container castings is equal to the twistlock height plus twistlock separation.
Twistlock float		Float condition with zero axial force. The distance between the container castings is in between closed and open state.

9.3.13 Twistlock separation and height is to be provided by the lashing manufacturer. If this information is not available, the twistlock flange height is to be taken as 28 mm and the twistlock separation as 18 mm for FATs, SATs and manual twistlocks.

9.3.14 In the analysis of container stacks, it may be assumed that shear deformation of twistlocks can be ignored.

9.3.15 Initial displacement of containers due to tolerances in container fittings will be considered in conjunction with the stowage arrangement proposed. Generally, initial displacement may be neglected in calculation procedures for conventional stowages.

9.4 Allowable forces on containers, fittings and lashing devices

9.4.1 The racking force of the container panels is calculated from the transverse shear deformation and the shear stiffness. The absolute racking force on the container end and side panels must not exceed the allowable racking force specified in *Table 14.9.6 Allowable forces in containers in stacks with the same base size.*

9.4.2 The vertical force in the corner post is to be calculated from the compression of the post plus the vertical force due to shear in the end wall acting on the post. The maximum compressive force in each corner post of the container must not exceed the vertical forces at each top corner casting and in each corner post specified in *Table 14.9.6 Allowable forces in containers in stacks with the same base size*.

9.4.3 The maximum vertical compressive force in the twistlock is not to be greater than the allowable vertical forces at each bottom corner casting, compression and the maximum vertical tensile force in the twistlock is not to be greater than the allowable vertical corner pull-out force at each bottom corner casting.

9.4.4 The twistlock tensile load is to be less than the safe working load.

9.4.5 The forces and force components in the lashing devices must not be greater than the allowable lashing forces on the corner castings and the safe working load of the lashing device.

9.4.6 *Table 14.9.6 Allowable forces in containers in stacks with the same base size* and *Table 14.9.7 Allowable compression forces for posts and corner castings of 40 ft and 45 ft containers in mixed stacks* show the values for allowable forces for ISO containers according to ISO 1496-1:1990 including Amendment Nos. 1, 2, 3 and 4. Other configurations will be specially considered.

9.4.7 The allowable forces for containers of other dimensions, e.g. 24 ft, 48 ft and 53 ft, will be determined on the basis of the values in *Table 14.9.5 Allowable forces in containers in stacks with the same base size* and of the forces for which the container has been certified.

9.4.8 The resultant forces in the securing devices and supports are not to exceed the allowable safe working loads for which the device has been approved, *see Pt 3, Ch 14, 2 Fixed cargo securing fittings, materials and testing* and *Pt 3, Ch 14, 3 Loose container securing fittings, materials and testing*.

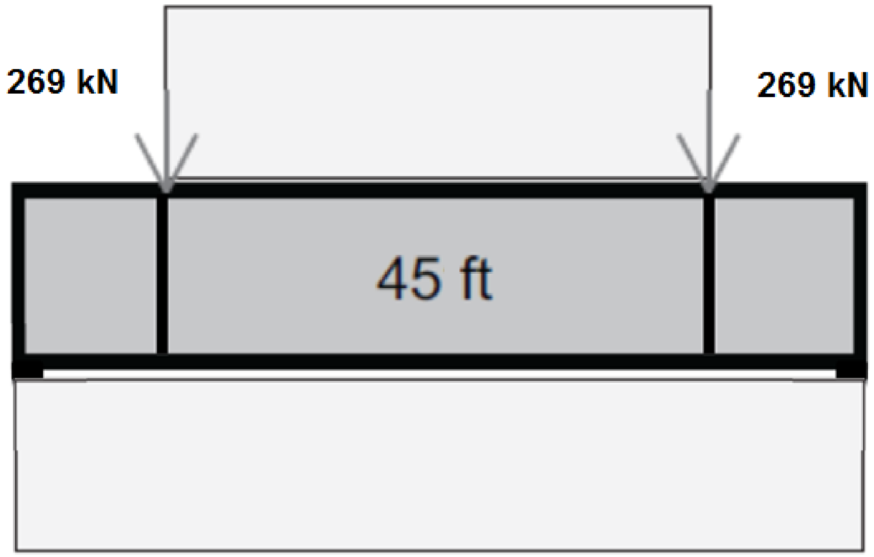
9.4.9 The forces in lashing devices, where fitted, are not to exceed the allowable safe working loads (SWLs) of the lashings as determined from *Pt 3, Ch 14, 3 Loose container securing fittings, materials and testing*.

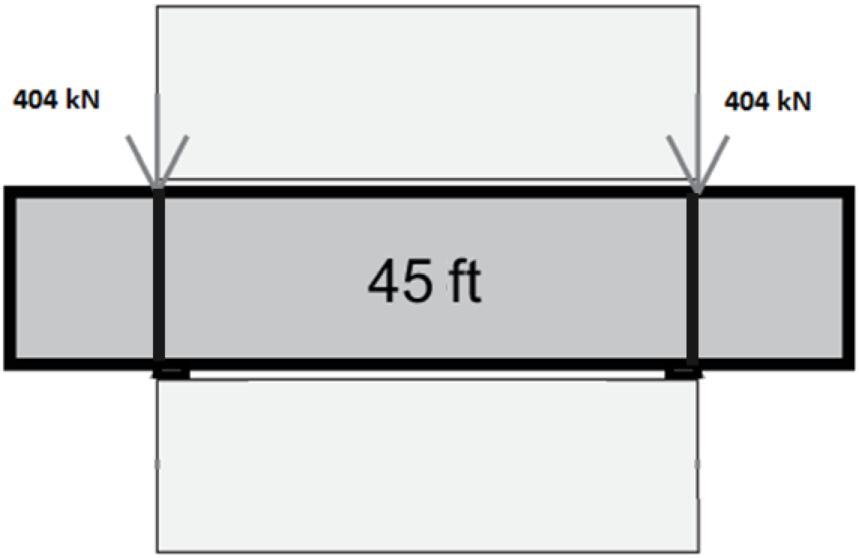
9.4.10 *Table 14.3.2 Test loads and test modes for loose container securing fittings* and *Table 14.2.2 Test loads and test modes for fixed container securing fittings* show the allowable safe working loads for loose fittings, including twistlocks, and securing devices. The forces in lashing devices are not to exceed the safe working loads (SWLs).

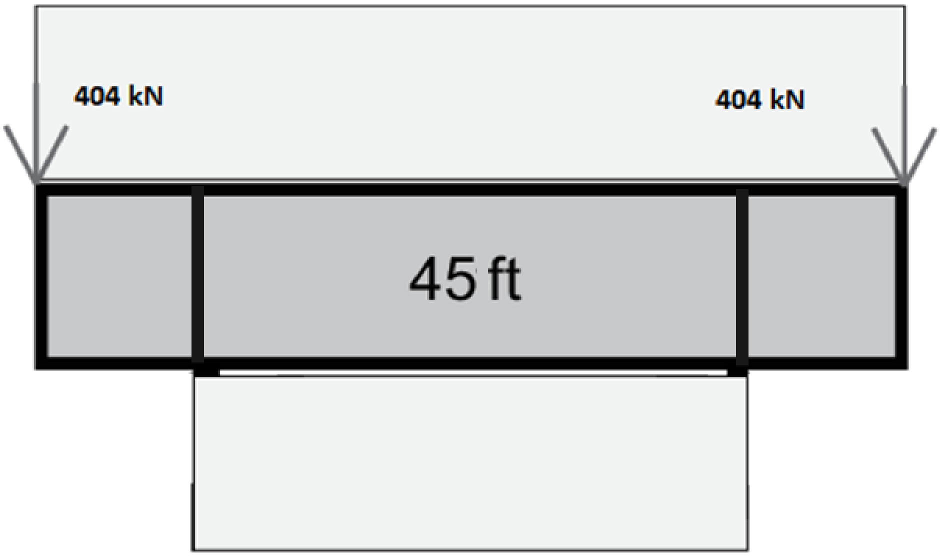
9.4.11 *Table 14.3.2 Test loads and test modes for loose container securing fittings* show the allowable shear force of the twistlocks. The calculated twistlock shear force is to be increased by 10 per cent due to misalignment, corrosion and design tolerances before comparing to the safe working load.

9.4.12 When Fully Automatic Twistlocks (FATs) are used, it is to be ensured that at least one of the port and starboard FATs at each end is in compression. This is to ensure that the FATs would not become disengaged.
Table 14.9.5 has been renumbered 14.9.6 and included below 9.4.13.

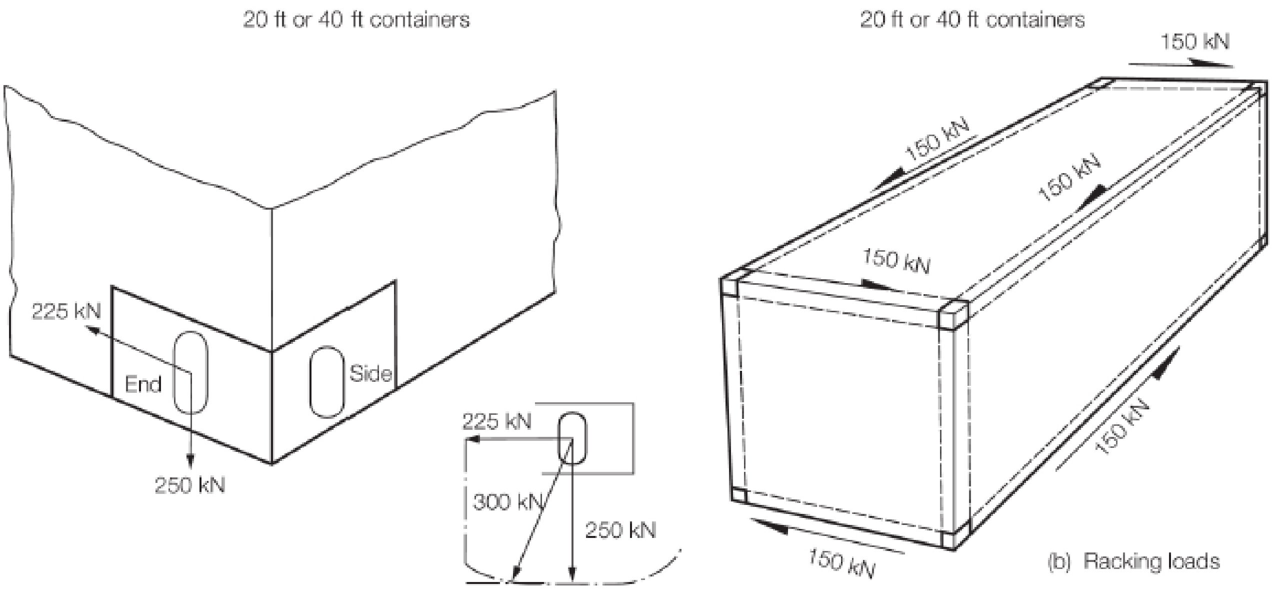
Table 14.9.7 Allowable compression forces for posts and corner castings of 40 ft and 45 ft containers in mixed stacks

Allowable force in kN






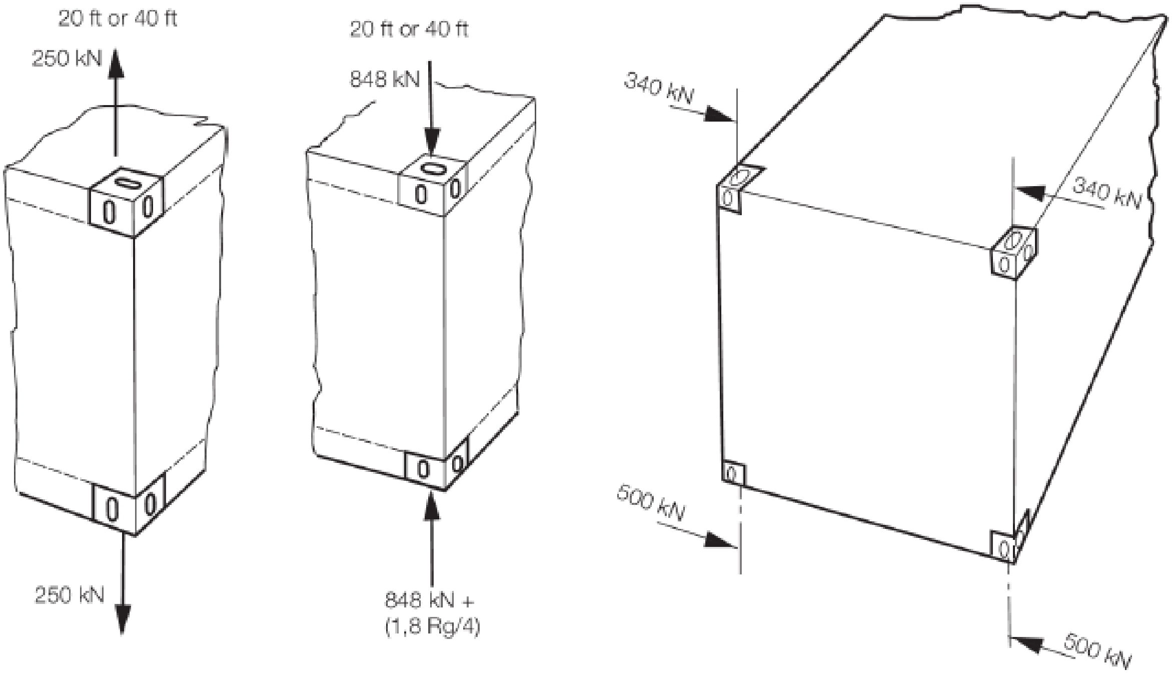
Note 1. *See* Notes 1 and 2 of *Table 14.9.6 Allowable forces in containers in stacks with the same base size*
Note 2. The allowable compression force for the bottom container casting may be increased by (1,8 Rg)/4



(a) Corner casting lashing loads

(b) Racking loads

20 of 40 ft container, tension or compression



(c) Vertical corner pull-out and compressive forces

(d) Transverse compressive forces

Figure 14.9.2 Allowable forces for 20 ft or 40 ft containers constructed to ISO 1496-1:1990 including Amendment Nos. 1, 2 and 3

Part 4, Chapter 1
General Cargo Ships

■ *Section 4*
Deck structure

4.3 Deck stiffening

(*Part only shown*)

Table 1.4.1 Strength/weather deck plating

Location	Minimum thickness, in mm~~, *see also Pt 4, Ch 1, 4.2 Deck plating 4.2.1*~~	
	Longitudinal framing	Transverse framing
Symbols		
L, k_L, *k*, ρ, *s, S* as defined in *Pt 4, Ch 1, 1.5 Symbols and definitions 1.5.1* $f = 1{,}1 - \frac{s}{2500S}$ but not to be taken greater than 1,0 $f_1 = \frac{1}{1+\left(\frac{s}{1000S}\right)^2}$ h_4 = tank head, in metres, as defined in *Pt 3, Ch 3, 5 Design loading* s_1 = *s* but is not to be taken less than the smaller of $470 + \frac{L}{0.6}$ mm or 700 mm F_D = as defined in *Pt 3, Ch 4, 5.7 Local reduction factors* L_1 = *L* but need not be taken greater than 190 m.		
Note 1. The thickness derived in accordance with (1) is also to satisfy the buckling requirements of *Pt 3, Ch 4, 7 Hull buckling strength*. Note 2. The deck thickness is to be not less than the basic strength deck end ~~deck~~ thickness for taper as given in ~~*Pt 3, Ch 5 Fore End Structure* and *Pt 3, Ch 6 Aft End Structure*.~~ *Pt 3, Ch 3, Table 3.2.1 Taper requirements for hull envelope.*		

■ *Section 5*
Shell envelope plating

5.4 Side shell

(*Part only shown*)

Table 1.5.2 Bottom shell and bilge plating

Location	Minimum thickness, in mm~~, *see also Pt 4, Ch 1, 5.3 Bottom shell and bilge 5.3.1*~~	
	Longitudinal framing	Transverse framing
Symbols		
L, D, T, s, S, k_L, *k* as defined in *Pt 4, Ch 1, 1.5 Symbols and definitions 1.5.1* C_w is as defined in *Pt 4, Ch 1, 1.5 Symbols and definitions 1.5.1*. Where $L > 227$ m, C_w is not to be taken less than 6,446 m $f_1 = \frac{1}{1+\left(\frac{s}{1000S}\right)^2}$ $h_{T2} = (T + 0{,}5\, C_w)$, in metres but need not be taken greater than 1,2*T* m s_1 = *s*, but is not to be taken less than the smaller of $470 + \frac{L}{0{,}6}$ or 700 mm F_B = as defined in *Pt 3, Ch 4, 5.7 Local reduction factors* L_1 = *L* but need not be taken greater than 190 m R_B = bilge radius, in mm, *see* Note 3		
Note 1. The thickness derived in accordance with (1) is also to satisfy the buckling requirements of *Pt 3, Ch 4, 7 Hull buckling strength*. Note 2. The thickness of bottom shell or bilge plating is to be not less than the basic shell end thickness for taper as given in ~~*Pt 3, Ch 5, 3 Shell envelope plating* and *Pt 3, Ch 6, 3 Shell envelope plating*.~~ *Pt 3, Ch 3, Table 3.2.1 Taper requirements for hull envelope.* The basic shell end thickness for taper applied to the midship region bottom shell or bilge plating need not be taken greater than 16 mm. Note 3. Where longitudinally framed and the lowest side longitudinal lies a distance *a* mm above the uppermost turn of bilge and/or the outermost bottom longitudinal lies a distance *b* inboard of the lower turn of bilge, the bilge radius is to be taken as $R_B + \frac{(a+b)}{2}$ mm. In no case is *a* or *b* to be greater than *s*. Note 4. Where separate maximum sagging and hogging still water bending moments are assigned, F_B may be based on the hogging moment.		

(*Part only shown*)

Table 1.5.3 Side shell plating

Location	~~Thickness, in mm, *see also Pt 4, Ch 1, 5.4 Side shell 5.4.1*~~ Minimum thickness, in mm	
	Longitudinal framing	Transverse framing
Symbols		
L, *D*, *T*, *S*, *s*, k_L, *k*, as defined in *Pt 4, Ch 1, 1.5 Symbols and definitions 1.5.1* C_w is as defined in *Pt 4, Ch 1, 1.5 Symbols and definitions 1.5.1*. Where *L* > 227 m, C_w is not to be taken less than 6,446 m $f_1 = \dfrac{1}{1+\left(\dfrac{s}{1000S}\right)^2}$ $h_{T1} = T + C_w$ m but need not be taken greater than 1,36*T* $h_{T2} = T + 0{,}5C_w$ m but need not be taken greater than 1,2*T* $s_1 = s$, but is not to be taken less than the smaller of $470+\dfrac{L}{0{,}6}$ or 700 mm F_D, F_B = as defined in *Pt 3, Ch 4, 5.7 Local reduction factors* F_M = the greater of F_D or F_B $L_1 = L$, but need not be taken greater than 190 m		
Note 1. The thickness is also to satisfy the buckling requirements of *Pt 3, Ch 4, 7 Hull buckling strength*. Note 2. The thickness of side shell or sheerstrake plating is to be not less than the basic shell end thickness for taper as given in ~~*Pt 3, Ch 5, 3 Shell envelope plating* and *Pt 3, Ch 6, 3 Shell envelope plating*.~~ *Pt 3, Ch 3, Table 3.2.1 Taper requirements for hull envelope.* The basic shell end thickness for taper applied to the midship region side shell or sheerstrake plating need not be taken greater than 16 mm. The width of the sheerstrake (where of different thickness from the side shell) is to be not less than that required by *Table 2.2.1 Material classes and grades* in *Pt 3, Ch 2 Materials*. Note 3. The thickness of side shell need not exceed that determined from *Table 1.5.2 Bottom shell and bilge plating* for bottom shell, but using the spacing of side frames or longitudinals. ~~Note 4. Outside the Rule minimum region of higher tensile steel as defined in *Pt 3, Ch 3, 2.6 Vertical extent of higher tensile steel 2.6.1* the value of k_L may be taken as 1,0.~~ ~~Note 5~~Note 4. For the expressions contained in (i), where separate maximum sagging and hogging still water bending moments are assigned, F_D may be based on the sagging moment and F_B on the hogging moment.		

Section 6
Shell envelope framing

6.4 Primary supporting structure

Table 1.6.1~~(a)~~ Shell framing (longitudinal)

Location	Modulus, in cm^3
(3) Bottom and bilge longitudinals, *see* Notes 1, 2, 3 and 4	The greater of the following: (a) ~~$Z = yskh_{T2}l_e^2F_1$~~ $Z = \gamma skh_{T2}l_e^2F_1$ (b) ~~$Z = yskh_{T3}l_e^2F_1F_{sb}$~~ $Z = \gamma skh_{T3}l_e^2F_1F_{sb}$
Symbols	
L, D, T, s, k, k_L, *ρ*, as defined in *Pt 4, Ch 1, 1.5 Symbols and definitions 1.5.1* *l_e = as defined in Pt 4, Ch 1, 1.5 Symbols and definitions 1.5.1*, but is not to be taken less than 1,5 m except in way of the centre girder brackets required by *Pt 4, Ch 1, 8.5 Floors 8.5.3* where a minimum span of 1,25 m may be used ~~1,5 m except in way of the centre girder brackets required by *Pt 4, Ch 1, 8.5 Floors 8.5.3* where a minimum span of 1,25 m may be used~~ $l_{e1} = l_e$ in metres, but is not to be taken less than 2,5 m and need not be taken greater than 5,0 m $\cancel{c_1 = \dfrac{60}{225-165F}}$ $c_1 = \dfrac{60}{225-165F_D}$ at deck $c_1 = 1{,}0$ at $\dfrac{D_2}{2}$ $c_1 = \dfrac{75}{225-150F_B}$ at baseline ~~C_1 intermediate values by interpolation~~ Intermediate values of c_1 are to be obtained by interpolation. $D_1 = D_2$, in metres, but is not to be taken less than 10 and need not be taken greater than 16 ~~D2~~ $D_2 = D$, in metres, but need not be taken greater than 1,6*T* ~~F_B,F_D~~ F_B, F_D as defined in *Pt 3, Ch 4, 5.7 Local reduction factors*	

$F_1 = \frac{D_2 c_1}{4D_2 + 20h_5}$ for side longitudinals above $\frac{D_2}{2}$

$F_1 = \cancel{\frac{D_2 c_1}{25D_2 + 20h_5}}$ $\frac{D_2 c_1}{25D_2 - 20h_5}$ for side longitudinals below $\frac{D_2}{2}$ and for bottom longitudinals

~~Minimum F_1 = 0,14~~ F_1 is not to be taken less than 0,14

~~for side longitudinals below $\frac{D_2}{2}$ and bottom longitudinals~~

L_1 = L but need not be taken greater than 190 m

F_s is a fatigue factor for side longitudinals to be taken as follows:

(a) For built sections and rolled angle bars

$F_s = \frac{1{,}1}{k}\left[1 - \frac{2b_{f1}}{b_f}(1-k)\right]$ at 0,6D_2 above the base line

F_s = 1,0 at D_2 and above~~, and F_{SB} at the base line intermediate values by linear interpolation~~

$F_s = F_{SB}$ at the base line.

Intermediate values of F_s are to be obtained by interpolation.

(b) For flat bars and bulb plates $\frac{b_{f1}}{b_f}$ may be taken as 0,5

F_{SB} is a fatigue factor for bottom longitudinals = 0,5 (1 + F_s at 0,6D_2)

Where

b_{f1} = the minimum distance, in mm, from the edge of the face plate of the side longitudinal under consideration to the centre of the web plate, *see Pt 4, Ch 9, 5.2 Symbols 5.2.1* ~~in Chapter 9~~

$h_{T1} = C_W\left(1 - \frac{h_6}{D_2 - T}\right)F_\lambda$, in metres, for longitudinals above the waterline, at draught T, ~~where $\left(1 - \frac{h_6}{D_2 - T}\right)$ is not to be taken less than 0,7~~

Where $C_W\left(1 - \frac{h_6}{D_2 - T}\right)$ is not to be taken less than $\frac{L_1}{56}$ m for Type ‘B-60’ ships or less than the greater of $\frac{L_1}{70}$, or 1,20 for Type ‘B’ ships

$h_{T1} = \left[h_6 + C_W\left(1 - \frac{h_6}{2T}\right)\right]F_\lambda$, in metres, for longitudinals below the waterline at draught T.

h_{T1} need not exceed 0,86 $\left(h_5 + \frac{D_1}{8}\right)$ ~~f or~~ for $F_1 \leq 0{,}14$ and $\left(h_5 + \frac{D_1}{8}\right)$ ~~f or~~ for $F_1 > 0{,}14$

$h_{T2} = (T + 0{,}5C_W)$ ~~F_λ~~, in metres for bottom longitudinals but need not be taken greater than 1,2T

$h_{T3} = h_4 - 0{,}25T$, in metres

h_4 = load head required ~~by*Pt 4, Ch 1, 9.1 General*~~ by *Pt 4, Ch 1, 9.1 General* for deep tanks

h_5 = vertical distance, in metres, from longitudinal to deck at depth, D_2

h_6 = vertical distance, in metres, from the waterline at draught T to the longitudinal under consideration

b_f = the width of the face plate, in mm, of the side longitudinal under consideration, *see Pt 4, Ch 9, 5.2 Symbols 5.2.1* ~~in Chapter 9~~

C_W = a wave head, in metres = $7{,}71 \times 10^{-2} L e^{-0{,}0044L}$ where e = base of natural logarithms 2,7183

F_λ = 1,0 for $L \leq 200$ m

= [1,0 + 0,0023(L – 200)] for L > 200 m

$\gamma = 0{,}002 l_{e1} + 0{,}046$

NOTES

Note *1*. The buckling requirements of ~~*Pt 3, Ch 4,7*~~ *Pt 3, Ch 4, 7 Hull Buckling strength* are to be complied with. The ratio of the web depth, d_w, to web thickness, t, is to comply with the following requirements:

(a) Built up profiles and rolled angles:

$\cancel{\frac{d_w}{t} \leq 60\sqrt{K_L}}$ $\frac{d_w}{t} \leq 60\sqrt{k_L}$

(b) Flat bars:

$\cancel{\frac{d_w}{t} \leq 18\sqrt{K_L}}$ $\frac{d_w}{t} \leq 18\sqrt{k_L}$ when continuous at bulkheads

$\cancel{\frac{d_w}{t} \leq 15\sqrt{K_L}}$ $\frac{d_w}{t} \leq 15\sqrt{k_L}$ when non-continuous at bukheads

Note *2*. Where struts are fitted midway between transverses in way of double bottom tanks, or double skin construction, the modulus of the bottom or side longitudinals may be reduced by ~~50k~~ 50k per cent from that obtained from the locations (1), (2), or (3) as applicable.

Note *3*. Where the bilge radius exceeds the Rule height of a double bottom, the modulus of the longitudinal above this nominal height is to be derived from the location (1) or (2) as applicable.

Note *4*. Where no bilge longitudinals are fitted and bilge brackets are required by location (3) in ~~Table 1.5.2~~ *Table 1.5.2 Bottom shell and bilge plating*, at least two brackets are to be fitted.

Table 1.6.2~~(b)~~ Shell framing (longitudinal)

Location	Modulus, in cm^3
(3) Bottom and bilge longitudinals, *see* Notes 1, 2, 3 and 4	The greater of the following: (a) ~~$Z = yskh_{T2} l_e^2 F_1 F_{sb}$~~ $Z = \gamma skh_{T2} l_e^2 F_1 F_{sb}$ (b) ~~$Z = yskh_{T3} l_e^2 F_1 F_{sb}$~~ $Z = \gamma skh_{T3} l_e^2 F_1 F_{sb}$

Symbols

L, D, T, s, k, ρ, as defined in *Pt 4, Ch 1, 1.5 Symbols and definitions 1.5.1*

l_e = as defined in *Pt 4, Ch 1, 1.5 Symbols and definitions 1.5.1*, but is not to be taken less than 1,5 m except in way of the centre girder brackets required by *Pt 4, Ch 1, 8.5 Floors 8.5.3* where a minimum span of 1,25 m may be used

~~1,5 m except in way of the centre girder brackets required by *Pt 4, Ch 1, 8.5 Floors 8.5.3* where a minimum span of 1,25 m may be used~~

$l_{e1} = l_e$ in metres, but is not to be taken less than 2,5 m and need not be taken greater than 5,0 m

$c_1 = \cancel{\dfrac{60}{225 - 165F}}\ \dfrac{60}{225 - 165F_D}$ at deck

$c_1 = 1{,}0$ at $\dfrac{D_2}{2}$

$c_1 = \dfrac{75}{225 - 150F_B}$ at baseline

~~*C*1intermediate values by interpolation~~ Intermediate values of c_1 are to be obtained by interpolation.

$D_1 = D_2$, in metres, but is not to be taken less than 10 and need not be taken greater than 16

~~*D2*~~ $D_2 = D$, in metres, but need not be taken greater than $1{,}6T$

F_B,F_D as defined in *Pt 3, Ch 4, 5.7 Local reduction factors*

$F_1 = \dfrac{D_2 c_1}{4D_2 + 20h_5}$ for side longitudinals above $\dfrac{D_2}{2}$

$F_1 = \cancel{\dfrac{D_2 c_1}{25D_2 + 20\lambda_5}}\ \dfrac{D_2 c_1}{25D_2 - 20h_5}$ for side longitudinals below $\dfrac{D_2}{2}$ and for bottom longitudinals

~~Minimum F_1 = 0,14~~

F_1 is not to be taken less than 0,14

~~for side longitudinals below $\dfrac{D_2}{2}$ and bottom longitudinals~~

$L_1 = L$ but need not be taken greater than 190 m

F_s is a fatigue factor for side longitudinals to be taken as follows:

(a) For built sections and rolled angle bars

$\cancel{F_s = \dfrac{1{,}1}{k}\left[1 - \dfrac{2b_{f1}}{b_f}(1-k)\right]}\ \ F_s = \dfrac{1{,}1}{k}\left[1 - \dfrac{2b_{f1}}{b_f}(1-k)\right]$ at $0{,}6D_2$ above the base line

$F_s = 1{,}0$ at D_2 and above, ~~and F_{sb} at the base line intermediate values by linear interpolation~~

$F_s = F_{SB}$ at the base line

Intermediate values of F_s are to be obtained by interpolation.

(b) For flat bars and bulb plates $\cancel{\dfrac{b_{f1}}{b_f}}\ \dfrac{b_{f1}}{b_f}$ may be taken as 0,5

F_{sb} is a fatigue factor for bottom longitudinals = 0,5 (1 + F_s at $0{,}6D_2$)

Where

b_{f1} = the minimum distance, in mm, from the edge of the face plate of the side longitudinal under consideration to the centre of the web plate, *see Pt 4, Ch 9, 5.2 Symbols 5.2.1* ~~in Chapter 9~~

~~h_{T1}~~ h_{T1} = ~~C_W~~ $C_w \left(1 - \dfrac{h_6}{D_2 - T}\right) F_\lambda$, in metres, for longitudinals above the waterline, at draught T~~, where $\left(1 - \dfrac{h_6}{D_2 - T}\right)$ is not to be taken less than 0,7~~

Where $\left(1 - \dfrac{h_6}{D_2 - T}\right)$ is not to be taken less than 0,7

$h_{T1} = \cancel{\left[h_6 + C_W\left(1 - \dfrac{h_6}{2T}\right)\right]}\ \ \left[h_6 + C_W\left(1 - \dfrac{h_6}{2T}\right)\right] F_\lambda$, in metres, for longitudinals below the waterline at draught T.

h_{T1} and h_{T2} need not exceed $0{,}86\left(h_5 + \dfrac{D_1}{8}\right)$ ~~f or~~ for $F_1 \leq 0{,}14$ and $\left(h_5 + \dfrac{D_1}{8}\right)$ ~~f or~~ for $F_1 > 0{,}14$

$h_{T2} = (T + 0{,}5C_W) F_\lambda$, in metres for bottom longitudinals

$h_{T3} = h_4 - 0{,}25T$, in metres, at the base line

$h_{T3} = h_4$, in metres, at and above $T/4$ from the base line.

Intermediate values of h_{T3} are to be obtained by interpolation.

h_4 = load head required ~~by*Pt 4, Ch 1, 9.1 General*~~ by *Pt 4, Ch 1, 9.1 General* for deep tanks

h_5 = vertical distance, in metres, from longitudinal to deck at depth, D_2

h_6 = vertical distance, in metres, from the waterline at draught T to the longitudinal under consideration

b_f = the width of the face plate, in mm, of the side longitudinal under consideration, *see Pt 4, Ch 9, 5.2 Symbols 5.2.1* ~~in Chapter 9~~

C_W = a wave head, in metres = $7{,}71 \times 10^{-2} L e^{-0{,}0044L}$ where e = base of natural logarithms 2,7183

$F_\lambda = 1{,}0$ for $L \le 200$ m

= $[1{,}0 + 0{,}0023(L - 200)]$ for $L > 200$ m

$\gamma = 0{,}002 l_{e1} + 0{,}046$

NOTES

Note *1*. The buckling requirements of ~~*Pt 3, Ch 4,7*~~ *Pt 3, Ch 4, 7 Hull buckling strength* are to be complied with. The ratio of the web depth, d_w, to web thickness, t, is to comply with the following requirements:

(a) Built up profiles and rolled angles:

$\cancel{\frac{d_w}{t} \le 60\sqrt{K_L}}$ $\frac{d_w}{t} \le 60\sqrt{k_L}$

(b) Flat bars:

$\cancel{\frac{d_w}{t} \le 18\sqrt{K_L}}$ $\frac{d_w}{t} \le 18\sqrt{k_L}$ when continuous at bulkheads

$\cancel{\frac{d_w}{t} \le 15\sqrt{K_L}}$ $\frac{d_w}{t} \le 15\sqrt{k_L}$ when non-continuous at bulkheads

Note *2*. Where struts are fitted midway between transverses in way of double bottom tanks, or double skin construction, the modulus of the bottom or side longitudinals may be reduced by ~~50k~~ 50*k* per cent from that obtained from the locations (1), (2), or (3) as applicable.

Note *3*. Where the bilge radius exceeds the Rule height of a double bottom the modulus of the longitudinal above this nominal height is to be derived from the location (1) or (2) as applicable.

Note *4*. Where no bilge longitudinals are fitted and bilge brackets are required by location (3) in ~~Table 1.5.2~~ *Table 1.5.2 Bottom shell and bilge plating*, at least two brackets are to be fitted.

■ *Section 2* Longitudinal strength

2.5 Design wave shear force

2.5.1 The design vertical wave shear force, Q_w, at any position along the ship is given by:

~~$Q_w = 3f_1 K_f M_{wo} / L$ kN~~

$Q_w = K_f K_2 Q_{wo}$ kN

where

Q_{wo} and K_2 are given in *Pt 3, Ch 4, 6.3 Design wave shear force*

~~= K_f is to be taken as follows, *see also Figure 2.2.2 Shear force factor K_f*:~~

K_f is to be taken as follows, *see also Figure 2.2.2 Shear force factor K_f*:

(a) Positive shear force:

K_f = 0 at aft end of *L*
= +0,836f_{fH} between 0,2*L* and 0,3*L* from aft
= ~~+0,70f_{fH} between 0,4*L* and 0,5*L* from aft~~ +0,70 at 0,4*L*
= –0,65f_{fS} ~~between 0,5*L* and 0,6*L* from aft~~ at 0,6*L*
= –0,91f_{fS} between 0,7*L* and 0,85*L* from aft
= 0 at forward end of *L*

(b) Negative shear force:

K_f = 0 at aft end of *L*
= +0,836f_{fS} between 0,15*L* and 0,3*L* from aft
= +0,65f_{fS} ~~between 0,4*L* and 0,5*L* from aft~~ at 0,4*L*
= ~~–0, 70f_{fH} between 0,5*L* and 0,6*L* from aft~~ -0,70 at 0,6*L*
= –0,91f_{fH} between 0,7*L* and 0,85*L* from aft
= 0 at forward end of *L*

Intermediate values to be determined by linear interpolation.

~~f_1, M_{wo},~~ f_{fS} and f_{fH} are defined in *Pt 4, Ch 2, 2.4 Design vertical wave bending moments 2.4.1*.

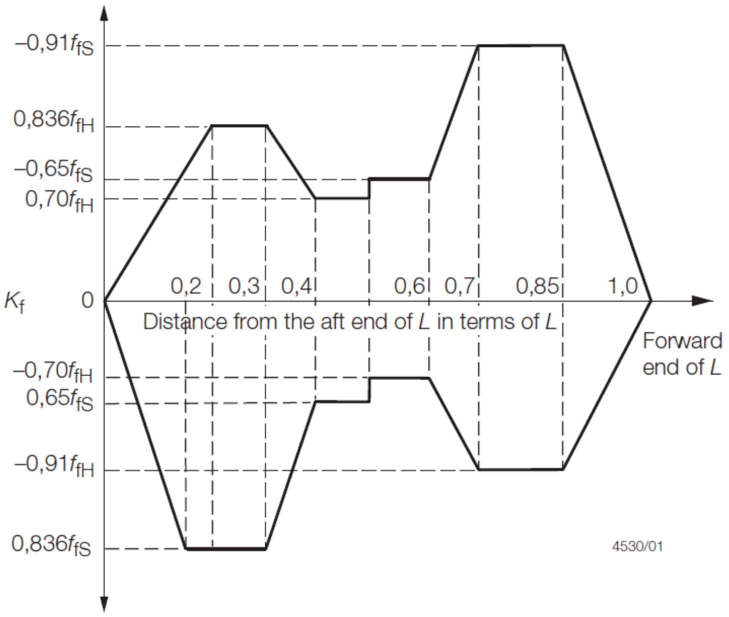


Figure 2.2.2 ***Shear force factor K_f***

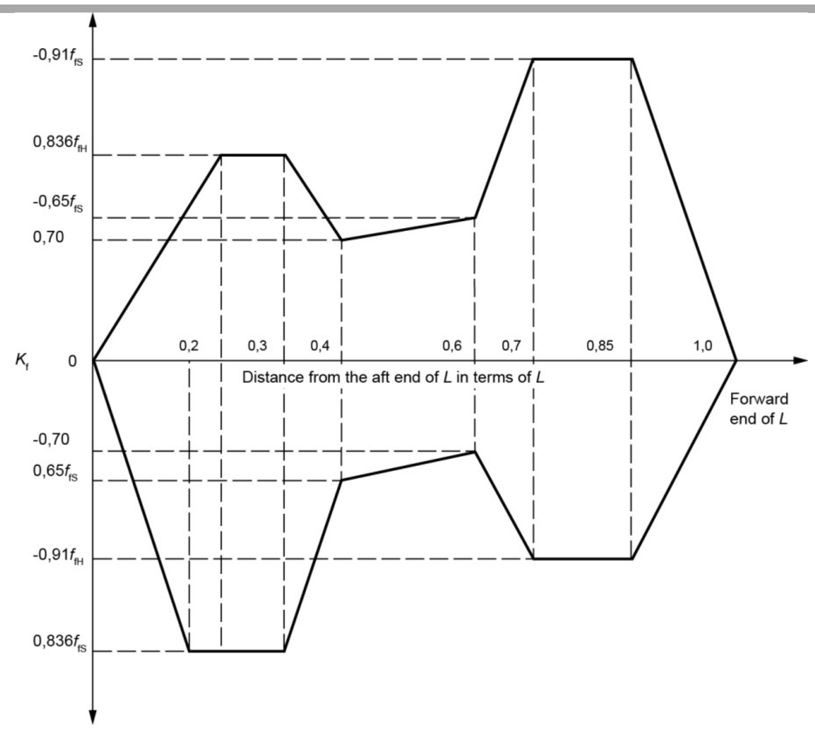


Figure 2.2.2 Shear force factor K_f

Part 4, Chapter 7
Bulk Carriers

■ *Section 1*
General

1.6 Information required for CSR bulk carriers

1.6.1 ~~In addition to the plans and documents required by the CSR the following are to be submitted:~~

- ~~Ice strengthening.~~
- ~~Freeboard plan or equivalent showing freeboards and items relative to the conditions of assignment.~~
- ~~In addition the supporting calculations given in *Pt 3, Ch 1, 5.2 Plans and supporting calculations 5.2.3* are to be submitted.~~

Plans and supporting documents/calculations are to be submitted for approval in accordance with the requirements of the CSR.

1.6.2 In addition, where not already required by the CSR, plans and supporting documents/calculations are to be submitted for approval as required by *Pt 3, Ch 1, 5.2 Plans and supporting calculations.*

1.6.3 A Ship Construction File is to be provided on board of the ship containing information to facilitate inspection/survey, repair and maintenance. As a minimum it is to include documentation and plans in accordance with the requirements of the CSR and in addition, where not already required by the CSR, documentation and plans as listed in *Pt 3, Ch 1, 5.3 Plans to be supplied to the ship.*

1.6.4 For CSR bulk carriers subject to *SOLAS - International Convention for the Safety of Life at Sea Chapter II-1 - Construction - Structure, subdivision and stability, machinery and electrical installations Part A-1 - Structure of ships Regulation 3-10 – Goal-based ship construction standards for bulk carriers and oil tankers*, a Ship Construction File (SCF) is to be provided in accordance with the requirements specified therein. Where not already required for the SCF, documentation and plans as listed in *Pt 3, Ch 1, 5.3 Plans to be supplied to the ship*, are also to be supplied.

1.6.5 In all cases, as required by the *CSR Pt 1, Ch 13 Ship in Operation - Renewal Criteria,* the mid-ship section plan to be supplied on board the ship is to include the minimum required hull girder sectional properties. Sectional properties are to be provided for transverse sections within the cargo length, i.e. each cargo hold, and are to include:

- sectional properties as defined in *CSR Pt 1, Ch 5, 1 Strength Characteristics of Hull Girder Transverse Sections;*
- the defined section modulus at Deck and at Bottom calculated with the gross offered thickness;
- the sectional area of the defined Deck and Bottom Zones calculated with the gross offered thickness; and
- the sectional area of the defined Neutral Axis Zone calculated with the gross offered thickness minus 0,5 t_c.

Part 4, Chapter 8
Container Ships

■ *Section 3*
Longitudinal strength

3.2 Longitudinal strength

3.2.1 Longitudinal strength calculations are to be made in accordance with the requirements of ~~*Pt 3, Ch 4 Longitudinal Strength*~~ *Pt 4, Ch 8, 16 Longitudinal strength calculations* and the additional notes contained in this Section and *Pt 4, Ch 8, 14 Direct calculation.*

~~3.2.2 The values of sagging f_{fS} and hogging f_{fH} correction factors due to non-linear effects of the hull shape are to be calculated in accordance with *Pt 4, Ch 8, 16.6 Design vertical wave bending moments 16.6.1* and are to be used in *Pt 3, Ch 4, 5.2 Design vertical wave bending moments 5.2.1* and *Pt 4, Ch 8, 14.2 Procedures for verification of primary structure scantlings 14.2.1*.~~

~~3.2.3 Additional longitudinal strength calculations are to be made in accordance with *Pt 4, Ch 8, 16 Additional calculations for longitudinal strength* for container ships meeting the following criterion:~~
~~$L \geq 90$m~~

~~3.2.4~~ 3.2.2 The wave vertical bending moments and shear forces given in *Pt 4, Ch 8, 16* ~~Additional calculations for longitudinal strength~~ *Longitudinal strength calculations* apply to mono-hull displacement ships in unrestricted service and are limited to ships meeting the following criteria:
(a) ~~90~~65 m $\leq L \leq$ 500 m
(b) $5 \leq L/B \leq 9$
(c) $2 \leq B/T \leq 6$
(d) $0{,}55 \leq C_B \leq 0{,}9$

For ships which do not meet the above criteria, the wave vertical bending moments and shear forces are to be specially considered.

3.2.3 In order to determine the local reduction factors, F_D and F_B, longitudinal strength calculations are to be made in accordance with the requirements of *Pt 3, Ch 4 Longitudinal strength* where M_w is to be calculated in accordance with *Pt 4, Ch 8, 16.6 Design vertical wave bending moments.*

3.2.4 For operation in sheltered water or short voyages, *see Pt 3, Ch 4, 5.2 Design vertical wave bending moments 5.2.3* and *Pt 3, Ch 4, 5.4 Minimum hull section modulus 5.4.3* where M_w is to be calculated in accordance with *Pt 4, Ch 8, 16.6 Design vertical wave bending moments.*

■ *Section 14*
Direct calculation

14.2 Procedures for verification of primary structure scantlings

14.2.1 For container ships as defined in *Pt 4, Ch 8, 1.3 Class notations 1.3.3*, the strength of the ship's primary structure scantlings of double bottom, side and transverse bulkheads is to be assessed in accordance with Part C of LR's *ShipRight SDA Procedure for container ships*. The vertical wave bending moments are to be calculated in accordance with *Pt 4, Ch 8, 16.6 Design vertical wave bending moments.* All other hull girder loads are to be calculated in accordance with ~~*Pt 4, Ch 8, 3.2 Longitudinal strength*~~ *Pt 4, Ch 8, 3.3 Combined longitudinal and torsional strength.*

14.3 Procedures for verification of structural response due to whipping, springing and fatigue

14.3.1 The ShipRight notations **WDA1** and **WDA2** are mandatory for container ships ~~when one or more of the following conditions apply~~ as indicated in *Table 8.14.1 Summary of direct calculation analysis requirements for container ships*, and where the ultimate strength of the hull girder is assessed against the extreme wave bending moments including whipping and wave impact loads, in accordance with LR's ShipRight Procedure ~~*Guidance Notes on the Assessment of Global Design Loads of Large Container Ships and Other Ships Prone to Whipping and Springing*~~ *Global Design Loads of Container Ships and Other Ships Prone to Whipping and Springing:*
~~(a) $L > 350$ m~~
~~(b) $L > 300$ m and one or more of~~
  ~~(i) $\left|f_{fS}\right| > 1{,}4$ or~~
  ~~(ii) $RA_{BF} > 0{,}2$ or~~
  ~~(iii) $RA_{BFU} > 0{,}2$~~

~~(c) Use of HT47 or above for the deck or hatch side coaming~~
~~(d) Use of HT36 or above for the bottom shell~~
~~(e) *B* > 32 m~~
~~Where:~~

~~f_{fS} = is defined in *Pt 4, Ch 2, 2.4 Design vertical wave bending moments 2.4.1*~~

~~RA_{BF} and RA_{BFU} are defined in *Pt 4, Ch 8, 3.2 Longitudinal strength 3.2.3*~~

~~*See Table 8.14.1 Summary of direct calculation analysis requirements for container ships.*~~

Table 8.14.1 Summary of direct calculation analysis requirements for container ships

Rule requirement *See* Note 1	Rule reference	ShipRight notation	Application criteria. If any of the following criteria apply then the appropriate analysis is required					
			Length criteria	Any of $\lvert f_{fS}\rvert$ > ~~1,4~~ 1,55 or ~~RA_{BF} > 0,2~~ ~~or~~ ~~RA_{BFU} > 0,2~~ f_{bow} > 1,85	$f_c > f_{sp}$	Deck or hatch side coaming steel grade ≥ HT47	Bottom steel grade ≥ HT36 *See Note 5*	Breadth criteria
LR's ShipRight SDA Procedure for container ships	*Pt 4, Ch 8, 1.3 Class notations 1.3.3*	**SDA**	*L*>150	—	—	—	—	*B* > 32
Non-linear ship motion analysis to calculate combined vertical, horizontal and torsional loads	*Pt 4, Ch 8, 14.1 Procedures for calculation of combined longitudinal and torsional strength 14.1.2*	—	*L* > 425	—	—	—	—	*B* > 60
Fatigue assessment	*Pt 4, Ch 8, 14.3 Procedures for verification of structural response due to whipping, springing and fatigue 14.3.2*	**FDA** (*see* Note 3)	*L* > 350	—	*L* > 250	Yes	Yes	—
Whipping assessment Level 1 *See Note 4*	*Pt 4, Ch 8, 14.3 Procedures for verification of structural response due to whipping, springing and fatigue 14.3.1*	**WDA1**	—	—	—	—	—	*B* > 32
Whipping assessment Level 2 *See Note 4*	*Pt 4, Ch 8, 14.3 Procedures for verification of structural response due to whipping, springing and fatigue 14.3.1*	**WDA2**	*L* > 350	~~*L* > 300~~ *L* > 275	—	Yes	Yes	—
Springing assessment See Note 2	*Pt 4, Ch 8, 14.3 Procedures for verification of structural response due to whipping, springing and fatigue 14.3.2*	FDA SPR	*L* > 350	—	*L* > 250	Yes	Yes	—
Symbols and definitions								

f_{fS} is defined in *Pt 4, Ch 8, 16.6 Design vertical wave bending moments 16.6.1*

f_{bow} is defined in *Pt 4, Ch 8, 16.6 Design vertical wave bending moments 16.6.3*

f_c is a wave encounter frequency at which it is expected that springing will become important

$$= \frac{1,3}{2\pi}\left(1+\frac{1,3V}{2g}\right) \text{ Hz}$$

f_{sp} is the natural frequency of the 2 node hull girder vertical bending mode in Hz. This can be very approximately calculated as:

$$= \left(\frac{1,1}{\pi L^2}\right)\sqrt{\frac{EI10^5}{1,8BT_dC_b}} \text{ Hz}$$

V = speed in knots as defined in *Pt 3, Ch 1, 6.1 Principle particulars 6.1.10*
E = Young's modulus in N/mm^2
= 206000 N/mm^2 for steel
I = midship moment of inertia in m^4, *see Pt 3, Ch 4 Longitudinal Strength*
T_d = design (normal standard operating) draught, in metres
C_b, L, and B are given in *Pt 3, Ch 1, 6 Definitions.*

Note 1 The stated rule requirements may be deemed applicable to ships that do not meet the application criteria but where the structural configuration is such as to necessitate them.
Note 2 The results of the springing assessment may also need a fatigue assessment procedure to be undertaken.
Note 3 If ShipRight notation **FDA** is to be assigned, the requirements of LR's ShipRight FDA procedure are to be complied with; this may require calculations additional to those implied by *Pt 4, Ch 8, 14.3 Procedures for verification of structural response due to whipping, springing and fatigue 14.3.2*.
Note 4 A Level 2 Whipping Assessment may be carried out instead of a Level 1 Whipping Assessment at the Owner's request.
Note 5 This is applicable only when a bottom steel grade greater than or equal to HT36 is needed to satisfy the requirements of *Pt 4, Ch 8, 16 Longitudinal strength calculations.*

14.3.2 The ShipRight notation **FDA SPR** is mandatory for container ships ~~when one or more of the following conditions applies~~as indicated in *Table 8.14.1 Summary of direct calculation analysis requirements for container ships*, and where the fatigue performance of the hull girder taking into account the effects from springing, is assessed in accordance with LR's ShipRight Procedure ~~*Guidance Notes on the Assessment of Global Design Loads of Large Container Ships and Other Ships Prone to Whipping and Springing* ~~*Global Design Loads of Container Ship and Other Ships Prone to Whipping and Springing*, which also makes reference to LR's ShipRight FDA procedures:

~~(a) *L* > 350 m~~
~~(b) *L* > 250 m and $f_c > f_{sp}$~~
~~(c) Use of HT47 or above for the deck or hatch side coaming~~
~~(d) Use of HT36 or above for the bottom shell~~

~~Where~~

~~(a) f_c = is a wave encounter frequency at which it is expected that springing will become important~~

$$\cancel{= \frac{1,4}{2\pi}\left(1+\frac{1,4V}{2g}\right)} \ \text{~~Hz~~}$$

~~f_{sp} = is the natural frequency of the 2 node hull girder vertical bending mode in Hz. This can be very approximately calculated as:~~

$$\neq \quad \cancel{= \left(\frac{1,1}{\pi L^2}\right)\sqrt{\frac{EI10^5}{1,8BT_dC_b}}\ \text{Hz}}$$

~~*V* = speed in knots as defined in *Pt 3, Ch 1, 6.1 Principle particulars 6.1.10*~~

~~*E* = Young's modulus in N/mm^2~~

~~= 206000 N/mm^2 for steel~~

~~*I* = is the midship moment of inertia in m^4, see *Pt 3, Ch 4 Longitudinal Strength*~~

~~T_d = is the design (normal standard operating) draught, in metres~~

~~C_b, *L*, and *B* are given in *Pt 3, Ch 1, 6 Definitions.*~~

~~The fatigue assessment is to be carried out in accordance with LR's ShipRight Procedure *Guidance Notes on the Assessment of Global Design Loads of Large Container Ships and Other Ships Prone to Whipping and Springing*, which also makes reference to LR's ShipRight FDA procedures.~~

■ *Section 15*
Requirements for ships with large deck openings

15.4 Combined stress

(*Part only shown*)

15.4.2 The combined stress, σ_c, is to be less than the permissible stress given in *Table 8.15.4 Permissible stress.* σ_c, is to be taken as the greatest magnitude of the following stresses:

where

f_{fH}, f_{fS} = hogging and sagging vertical bending moment correction factors in accordance with ~~*Pt 4, Ch 2, 2.4 Design vertical wave bending moments* and *Pt 4, Ch 2, 3.2 Deck plating 3.2.3*~~ *Pt 4, Ch 8, 16.6 Design vertical wave bending moments 16.6.1*

■ *Section 16*
~~Additional calculations for longitudinal strength~~ Longitudinal strength calculations

16.1 Longitudinal extent of strength assessment

16.1.1 The stiffness, yield strength, buckling strength and hull girder strength assessment are to be carried out ~~between 0,2*L* and 0,75*L*~~ with due consideration given to locations where there are significant changes in the hull cross-section.

~~16.1.2 Additional strength assessments are to be made outside this area in accordance with *Pt 4, Ch 8, 3.2 Longitudinal strength, Pt 4, Ch 8, 3.3 Combined longitudinal and torsional strength* and *Pt 4, Ch 8, 14 Direct calculation*. As a minimum, the following locations are to be assessed:~~

~~(a) Forward end of the foremost cargo hold.~~

~~(b) Aft end of the aft most cargo hold.~~

16.7 Design vertical wave shear force

16.7.3 The distribution of the wave shear force, K_f, is to be taken as follows, *see also Pt 4, Ch 8,* ~~*16.7 Design vertical wave shear force 16.7.3*~~ *Figure 8.16.4 Distribution of vertical shear force Q_w along the ship length*.

(a) Positive shear force

$K_f = 0$ at aft end of *L*

$K_f = 5,2(0,3 + 0,7 f_{fH})$ between ~~0,15~~ 0,2 *L* and 0,3 *L*

$K_f = 4,0$ between 0,4 *L* and 0,55 *L*

~~$K_f = 5,7\,(0,25 + 0,75 f_{fS})$~~ $K_f = 5,7(0,25 + 0,75 f_{fS})$ between 0,65 *L* and 0,85 *L*

$K_f = 0$ at forward end of *L*

(b) Negative shear force

$K_f = -1,3(0,3 + 0,7 f_{fS})$ at aft end of *L*

$K_f = -5,2(0,3 + 0,7 f_{fS})$ between 0,15 *L* and 0,3 *L*

$K_f = -4,0$ between 0,4 *L* and 0,5 *L*

$K_f = -5,7 f_{fH}$ between 0,6 *L* and 0,75 *L*

$K_f = 0$ at forward end of *L*

~~Where:~~

~~f_{fH} and f_{fS} are as defined in *Pt 4, Ch 8, 16.6 Design vertical wave bending moments 16.6.1* Intermediate values to be obtained by linear interpolation~~

Intermediate values of K_f to be obtained by linear interpolation.

f_{fH} and f_{fS} are as defined in *Pt 4, Ch 8, 16.6 Design vertical wave bending moments 16.6.1*

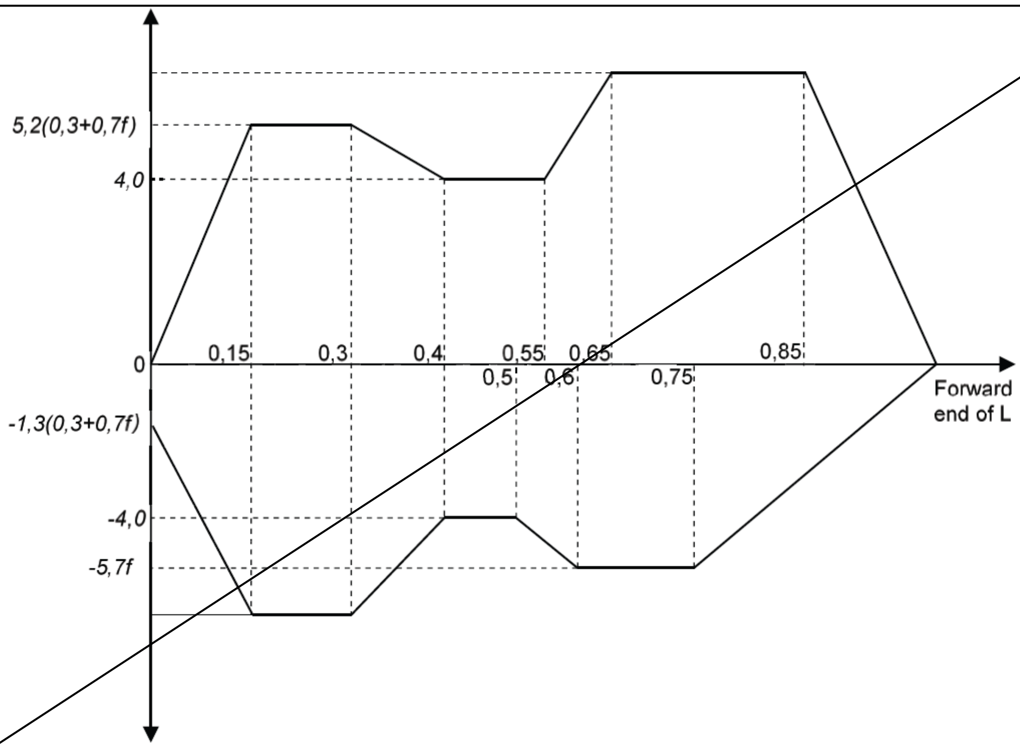


Figure 8.16.4 Distribution of vertical shear force Q_w along the ship length

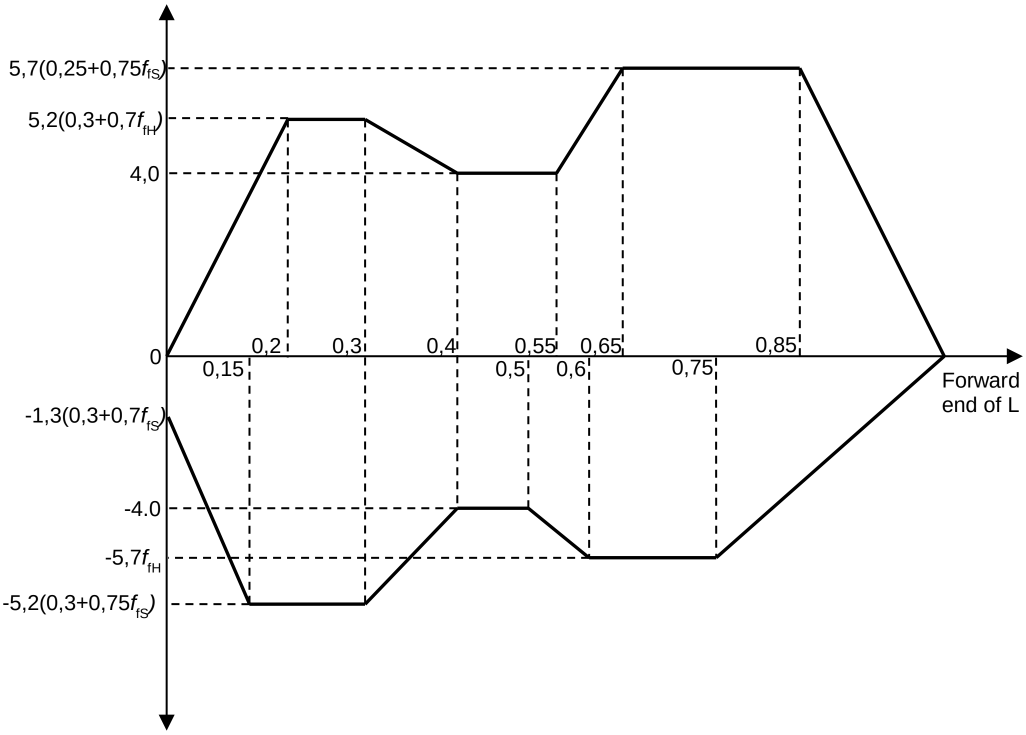


Figure 8.16.4 Distribution of vertical shear force Q_w along the ship length

Part 4, Chapter 9
Double Hull Oil Tankers

■ *Section 1*
General

1.6 Information required for CSR Double Hull Oil Tankers

1.6.1 ~~In addition to the plans required by *IACS Common Structural Rules (CSR)* the following additional plans and information is to be submitted:~~

- ~~Rudder, stock and tiller;~~
- ~~Ice Strengthening.~~
- ~~Freeboard plan or equivalent showing freeboards and items relative to the conditions of assignment.~~

Plans and supporting documents/calculations are to be submitted for approval in accordance with the requirements of the CSR.

1.6.2 In addition, where not already required by the CSR, plans and supporting documents/calculations are to be submitted for approval as required by *Pt 3, Ch 1, 5.2 Plans and supporting calculations.*

1.6.3 A Ship Construction File is to be provided on board of the ship containing information to facilitate inspection/survey, repair and maintenance. As a minimum it is to include documentation and plans in accordance with the requirements of the CSR and in addition, where not already required by the CSR, documentation and plans as listed in *Pt 3, Ch 1, 5.3 Plans to be supplied to the ship.*

1.6.4 For CSR oil tankers subject to *SOLAS - International Convention for the Safety of Life at Sea Chapter II-1 - Construction - Structure, subdivision and stability, machinery and electrical installations Part A-1 - Structure of ships Regulation 3-10 - Goal-based ship construction standards for bulk carriers and oil tankers*, a Ship Construction File (SCF) is to be provided in accordance with the requirements specified therein. Where not already required for the SCF, documentation and plans as listed in *Pt 3, Ch 1, 5.3 Plans to be supplied to the ship*, are also to be supplied.

1.6.5 In all cases, as required by the *CSR Pt 1, Ch 13 Ship in Operation - Renewal Criteria,* the mid-ship section plan to be supplied on board the ship is to include the minimum required hull girder sectional properties. Sectional properties are to be provided for transverse sections within the cargo length, i.e. each cargo tank, and are to include:

- sectional properties as defined in *CSR Pt 1, Ch 5, 1 Strength Characteristics of Hull Girder Transverse Sections;*
- the defined section modulus at Deck and at Bottom calculated with the gross offered thickness;
- the sectional area of the defined Deck and Bottom Zones calculated with the gross offered thickness; and
- the sectional area of the defined Neutral Axis Zone calculated with the gross offered thickness minus 0,5 t_c.

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